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Selenium Cells. DURING the past week we have received two inquiries from our readers as to the possibility of obtaining selenium cells in this country for purposes of experiment. We are not able to give the information, and shall be glad to hear from any quarter. Selenium cells have apparently dropped out of use since 1884, and no news of them has been heard of late years.

Predetermining Incandescent Filaments. AFTER ten years of practice on a large scale, the manufacture of the incandescent lamp may undoubtedly be said to be well understood, if only by comparatively few; but the fact remains that there is still much to be learned even by the manufacturer, when we consider the somewhat high percentage of variation from the desired product. The reason for this is well shown in the paper read by Mr. C. J. Reed before the American Institute of Electrical Engineers, in which the conditions upon which the illuminating power of a lamp depends are discussed. If it were possible to obtain in the finished lamp the exact conditions desired, the predetermination of the candle power of any lamp might be accomplished from known data. But, as Mr. Reed points out, the variation from the normal of but a single element upon which the illuminating power depends involves a deviation which makes the result very uncertain. Taking this fact into consideration, the actual results obtained speak well for the advance thus far made in the art.

The Honors to James D. Reid. No one is better known among American telegraphers to-day than Mr. James D. Reid, who has been appointed U. S. Consul at his native place, Dunfermline, in Scotland, and who leaves for his new post this week. The honors accorded him last week by the officials of the Western Union Telegraph Company and by the various telegraphic and other organizations were but a fitting recognition not only of his position as a veteran in the electrical field, but of his kindliness and goodness of heart. As the friend of Morse, and the first telegraph superintendent in the world, Mr. Reid would always have been regarded with respect; but he has not the less been the friend of the whole telegraphic fraternity, and hence he is looked upon also with affection throughout the craft. We are delighted to add our own testimony to Mr. Reid's sterling worth. We trust that his years may be long in the land of his birth, and that when tired of consulship he will come back, "just as young as he used to be," to see his friends in America.

Telephone Induction. CROSS-TALK on neighboring telephone lines has seemed to be so generally, and with apparently good reason, ascribed to the dynamic induction between wire and wire, that a proposition involving an almost total denial of this phenomenon as the true source of the trouble must attract the attention of all who are interested in telephony. In the excellent paper read by Mr. J. J. Carty before the New York Electric Club, that gentleman takes the stand, and shows by experiment, that cross-talk can take place without dynamic induction, and indeed that it is the static induction which is responsible for many of the troubles experienced on contiguous lines. The proofs which the author cites are certainly very striking, and would indicate that static induction, even if not of the predominating influence contended for by Mr. Carty, is certainly an important factor heretofore neglected. The influence of such induction between electric light and telephone wires is also alluded to by Mr. Carty, who demonstrates that a line perfectly balanced electro-dynamically might be entirely out of balance electrostatically, with reference to a contiguous wire.

The Heating of Wires. WE continue in this issue the able researches of Mr. A. E. Kennelly on the safe carrying capacity of wires, in which he enters into the question of the scope of some of the rules on this subject laid down by various bodies. Thus taking the English Board of Trade rule of 1,000 ampères to the square inch as the limiting capacity, he shows that this rule is open to the objection that it does not conform to the rule laid down by the Institution of Electrical Engineers, to the effect that the wires shall not heat above 150 degrees Fahrenheit when carrying twice their normal current. This latter rule, Mr. Kennelly shows, only conforms to the former in the case where the wire carries 200 ampères; above that, the following out of the Board of Trade rule would not be safe according to the other rule; while below it, it would lead to a waste in wire. Mr. Kennelly also points out the advantage under certain circumstances of dividing heavy circuits into multiple wires as a measure of economy. The tables of safe current carrying capacity of wires, together with the diagrams, will no doubt be welcomed by all engaged in the distribution of current for whatever purpose. These researches have been made at the instance of the Edison Electric Light Company, who have borne all the expenses attending them, and in thus giving them to the public, they unquestionably deserve the thanks and recognition of the electrical profession for the generous spirit shown. The publication of such work can have but one effect on the industry, and that is to correct serious errors and thus eliminate one of the elements of uncertainty which exist in this direction.

The Art of Interior Wiring. ONE of the most remarkable features of the introduction of the electric light has been the manner in which its progress has paralleled that of gas, in the early days. When gas was first brought to public notice, it was tried in one or two buildings; then a street or two were lit up, and soon it became popular for large stores and public buildings as well as for streets. But it was a longer time finding its way into dwellings, partly because of a fear as to its danger and largely because the method of putting in the service pipes was crude and bad. At last piping was brought down to a science, and since then gas has been in universal use. The electric light has gone, and is going, through exactly the same stages, and in ten years has reached the point that gas has hardly touched in fifty. One of the main things to-day is the improvement of the methods of interior wiring, and it may be broadly affirmed that this part of the work is as important as that connected with systems of generation. We are glad to be able this week to present a fully illustrated description of some recent advances in the art of interior wiring, in which the wires are carried throughout a building in definitely located tubes. We do not hesitate to express our conviction that the methods thus developed and perfected are destined to have a remarkable effect on the introduction of electric lighting, and that the merits of safety, convenience, permanence, and provision for the future will be appreciated quickly and enthusiastically. With such a system ready at hand, no electrician should now allow a single private house or public building of any pretensions throughout the country to be finished without being equipped with its interior conduits, so that at the earliest possible moment the wires may be introduced and the current turned on to the lamps.

Improvement in Electric Cars. IN a paper read before the American Society of Mechanical Engineers at their annual meeting, Mr. S. S. M'Farren draws attention to the past neglect of the requirements of the self-propelled car, referring specially to the electric street car. Even granted a good road bed, Mr. M'Farren points out that the standard practice of many years seems to have been entirely ignored, and that one of the great defects of the present type of cars is the short wheel base. By the adaptation of the suspension or similar systems long employed in railroad service, he claims that the wheel-base of the ordinary four-wheel street car could be increased 50 or 60 per cent. above the present length, and that the traction on curves would thereby be considerably lightened instead of increased. As another alternative, he looks with favor on the idea of using two independent trucks under the car. Again he finds much improvement to be possible in the type of brake employed on electric cars; with the high speeds at which they are now run, and the stiff grades which they successfully encounter, some more powerful brake than heretofore used seems to be indispensable, and he advocates the employment of a track brake applied by power derived either from a compressed air pump geared to the axle, or by the momentum of the car itself. Mr. M'Farren also alludes to a system of differential gearing, by which the speed of the car can be controlled at will by the motor operating at a constant speed. No doubt the improvements which Mr. M'Farren suggests are perfectly applicable to the modern street car, and, indeed, a number of them have already been applied, but in the short space of time in which the electric street car has sprung from the experimental stage to that of wide application, it could not have been expected that that thought which has been bestowed upon the other railroad systems could already be here applied. Nevertheless, the performance of electric street cars to-day is so much in advance of what could be accomplished with horses, or any other system, that it may well bear criticism, especially if that criticism points out the way to improvement.

Advances in Current Distribution. OUR readers have already been made acquainted through these columns with the work of Lieut. F. J. Patten in the field of multiplex telegraphy, and more recently in that of alternating current motors, and they will, therefore, be interested in his latest work, embodying a new system of electric distribution designed to accomplish all objects for which the electric current is employed in general practice. The system may broadly be characterized as a combination of the direct and the alternating current systems. Mr. Patten has carried out his idea in a three-wire system, in which the two outside wires are the outgoing leads and the central wire the return. The essential features of Mr. Patten's system consist in an arrangement by which one of the outside wires carries only the + currents generated by an alternating current machine; while the other outside wire carries only the — currents generated, the return wire taking both in succession. This distribution of the + and — currents is effected by means of a very simple commutator, and the effects which may be obtained by such an arrangement are apparent at once. It is evident that either of the + or — currents, being continuous, may be employed for any purpose to which the continuous current is adapted, while they may both be combined at any point to form an alternating current in any suitable apparatus. Thus, in the case of a motor, the field magnets are so wound that the fields are magnetized by continuous currents taken from the two outside circuits, the winding being such that although the currents in the circuits are ostensibly in opposite directions, their effect is made cumulative by connecting them inversely. In this way Mr. Patten is able to obtain *a constant magnetization by means of alternating currents*, a very important advance. On the other hand, the armature takes the alternating current, so that we have here a complete alternating motor system in which no commutator is employed. In the case of a transformer, the primary winding is connected to both the outside circuits, so that the primary coil has the ordinary alternating current passing through it, which is transformed to one of lower potential in the ordinary way. The continuous currents of either sign can be used for the charging of storage batteries, running of arc lamps, etc., so that, as claimed by Mr. Patten, the system is capable of furnishing current for all classes of apparatus without the use of commutators outside the generating station.

The Wiring System and Methods of the Interior Electrical Conduit Company.

If the question be asked: What is the greatest advance made during this century in the comfort, convenience and beauty of public and domestic interiors? there is but one answer possible—the introduction of the incandescent electric light. No sooner did the invention take practical and commercial shape than it at once appealed to the highest and most refined instincts of a cultivated people. It suggested new possibilities to the architect and decorator. It gave to its patrons a softer, steadier light, that soothed the eye and could be placed at will wherever need or fancy dictated. It saved choice pictures from decay, rescued books and tapestries from smudge and rot, and left paint and metal in their pristine freshness. It did not taint or vitiate the air, but brought with its cheerful ray a gentle exhilaration that might well be classed with its more direct hygienic benefits, so that not only did it promote the cleanliness that comes next to godliness, but was hailed as the very type and embodiment of the ideal "sweetness and light."

In no respect has the incandescent light fallen short of its purpose as the boon that the popular imagination at once foresaw. It has proved to be that refinement of artificial illumination where simplicity has become the last expression of ingenuity and invention. Every one recognizes its foremost position among the gifts of scientific discovery to our age. Already the criticism that it is a luxury is hushed, for it has been brought within the reach of everybody. A luxury is only a necessity that some cannot afford.

But, while this is so true that there is no longer any need to emphasize or enlarge upon it, the fact remains that until a very recent date the methods of introducing the electric circuits, to convey current into buildings of whatever class, have been crude and barbarous in the extreme. The dynamo has been brought to the highest state of efficiency; the lamp has a longer life and a greater brilliancy than ever; the arrangements for carrying the current all over a large district are scientific and successful; but when we come to the details of interior wiring they are often found to be such that one wonders how it is that the light has survived and made its way in spite of them.

We go into one of the large new office buildings that are among the finest ornaments of modern New York. We see a dozen men at work around the different floors, annoying tenants in the endeavor to get current to the lamps. We are told that no fewer than 20 or 30 leakages developed immediately when the current was turned on, and that new troubles occur daily. The wires are not in sight, but are all laid in the plaster, and every effort to get at them involves destruction of walls, decorations and woodwork. Many of the ceilings look as though Mercator's projection of the world had been drawn on them, and some of the fixtures suggest that a water-pipe had burst near by, so stained and cracked are the walls where the cut was made to reach defective insulation. The owner is in despair, the architect storms at the wiring contractor, and the casual but observant public makes one more note against the poor science of electrical insulation and installation.

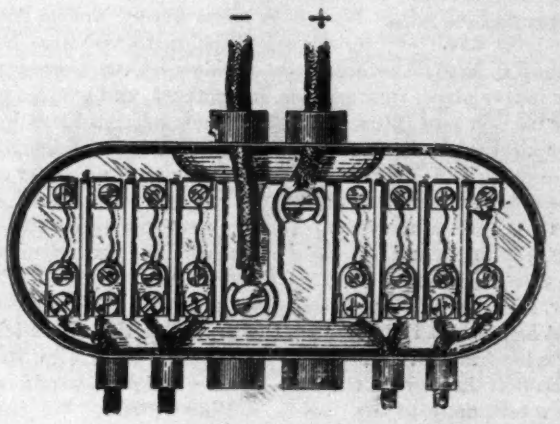
We go up town in New York, and step into one of the palatial homes of the residential quarter. The electric light has been introduced, but at what a price! This beautiful frescoing is irretrievably damaged; that handsome wall is grossly disfigured by heavy, clumsy cleats and moldings, and the whole house has been dealt with in such a way by the wiring men that the occupants literally wring their hands in despair, and they cry out indignantly that even such a blessing as the electric light may be had at too great a cost. They are fortunate if, after a while, the work does not develop serious defects and require to be done again from beginning to end.

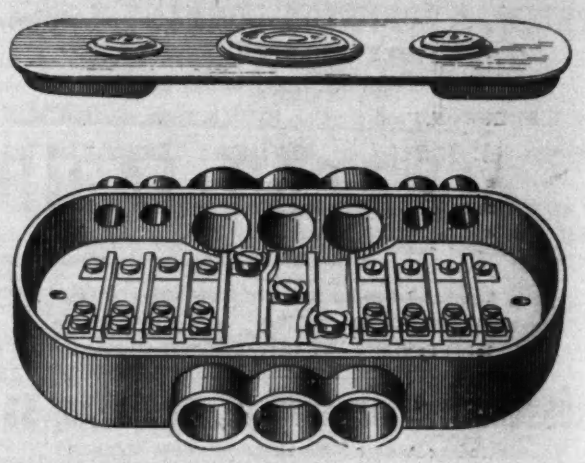
These are not exaggerated cases. Every electric lighting man knows that such instances abound. In fact, there is no help for them unless some system be provided and offered that will enable interior wiring to be done in a scientific manner. If the methods hitherto employed are in deed the final ideas that electrical invention has to offer on the subject of interior wiring, then gas will not only die hard, but be an unconscionable time doing it.

Moreover, as matters have stood hitherto, the greatest difficulty has arisen in regard to the wiring of the new buildings that are as yet remote from central stations. The owner has not cared to go to the expense of placing circuits that may not be utilized for a long time to come, and which when he requires them may prove useless, and as he looks at other fine structures that have been hacked to pieces in the effort to render their wires available, he hesitates to subject his own property to such treatment.

Is there no remedy for this discreditable condition of affairs? Must wires still go into the plaster, and if they are grounded or in need of reinforcement of any kind, must the walls be torn asunder? Must the wires still run haphazard, as crooked as the streets of Boston, and be hidden under tasteless moldings that are often as dangerous as they are ugly? Cannot architects be enabled to lay out their plans for the inclusion of the lighting wires and other classes of circuits as systematically, as intelligently, and as comprehensively as they do for water, gas, or steam?

In answer to such vital questions, we are able to state that a system has been ingeniously worked out which seems to avoid all these difficulties, brings interior wiring up to the high scientific and technical standard already attained by the other branches of electrical service, and which wins the enthusiastic admiration of every electrician, architect, builder, fire underwriter or real estate owner to whom it is shown. The advance in the art is so great that when once the system is explained, wiring on no other plan will be tolerated, its advocates believe; and there is, further, the great practical recommendation that the system affords economy and saving as compared with the older methods. The system in question is that of the Interior Electrical Conduit Company, of this city, and its many advantages are the result of a long familiarity with the difficult conditions existing, coupled with great ingenuity in the evolution of details and special devices, all harmonizing with the requirements of the most rigidly practical and scientific judges.





FIGS. 2 AND 3.—INTERIOR AND EXTERIOR OF JUNCTION BOX.

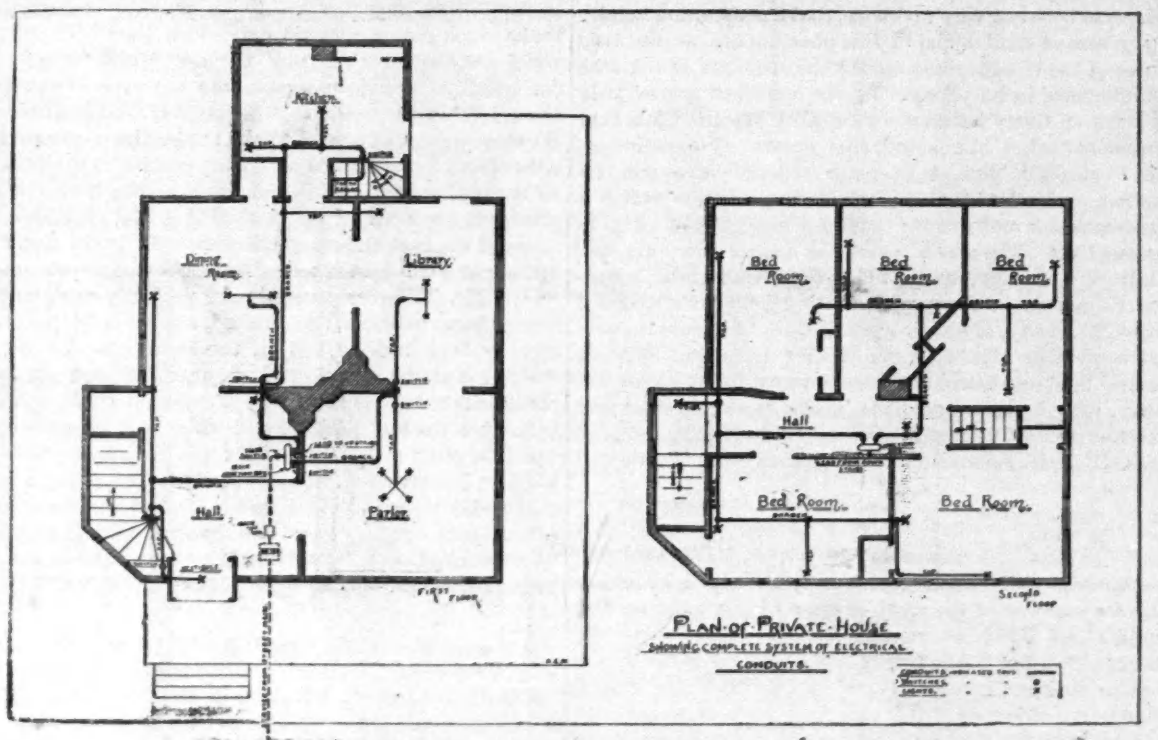
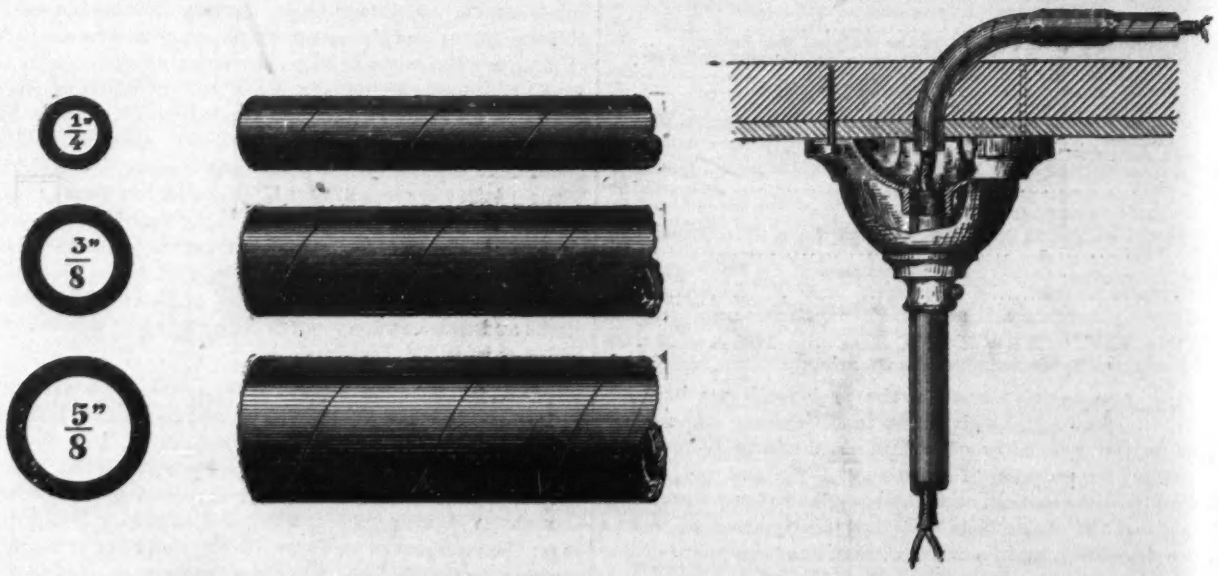


FIG. 1.—PLAN OF PRIVATE HOUSE WITH INTERIOR CONDUITS.

Broadly stated, the system of the Interior Electrical Conduit Company consists in the use of a light flexible insulating tube or conduit, which is carried through a building, pretty much as gas pipe or water pipe is, and which serves as a duct or repository for the distribution wires. The peculiar nature and advantages of the work are shown in the illustrations, Figs. 1 to 11, herewith. The plan is so simple when worked out that the very absence of complexity serves to hinder a quick appreciation of its remarkable utility. As a new departure, it is nothing short of revolutionary, yet the ease with which it can be applied to any class of work insures its immediate and universal adoption. But the idea of the tube or conduit has combined or associated with it the use of a new and ingenious insulated wire known as the "safety conductor." These special features are, in turn, the appropriate and adequate complements of a scientific "system of distribution." As the result of the perfect relation of these three elements, the conduit, the safety conductor and the system of distribution, we have five cardinal points, not of simple superiority, but of absolute necessity, without any one of which interior wiring tends to become the failure above portrayed. These five points are: 1, *Safety;* 2, *Convenience;* 3, *Accessibility;* 4, *Economy;* and, 5, *Durability.*



FIGS. 4 AND 5.—SIZES OF STRAIGHT TUBE, AND AN ELBOW TO OUTLET.

A brief consideration of each of these will bring out clearly in a most interesting manner the essential and fundamental features of the company's system. It is needless to add that there are many corollaries to these main advantages, but with such important points established, the reader will be quick to grasp the others for himself.

1. *Safety.*—The whole business of insurance is founded on the idea of safety. If the electric light in his house or

property is not safe, no man wants it; and even if he wants it, the underwriters will be prompt to interpose their "Thou shalt not," under penalty of the loss of all insurance. No

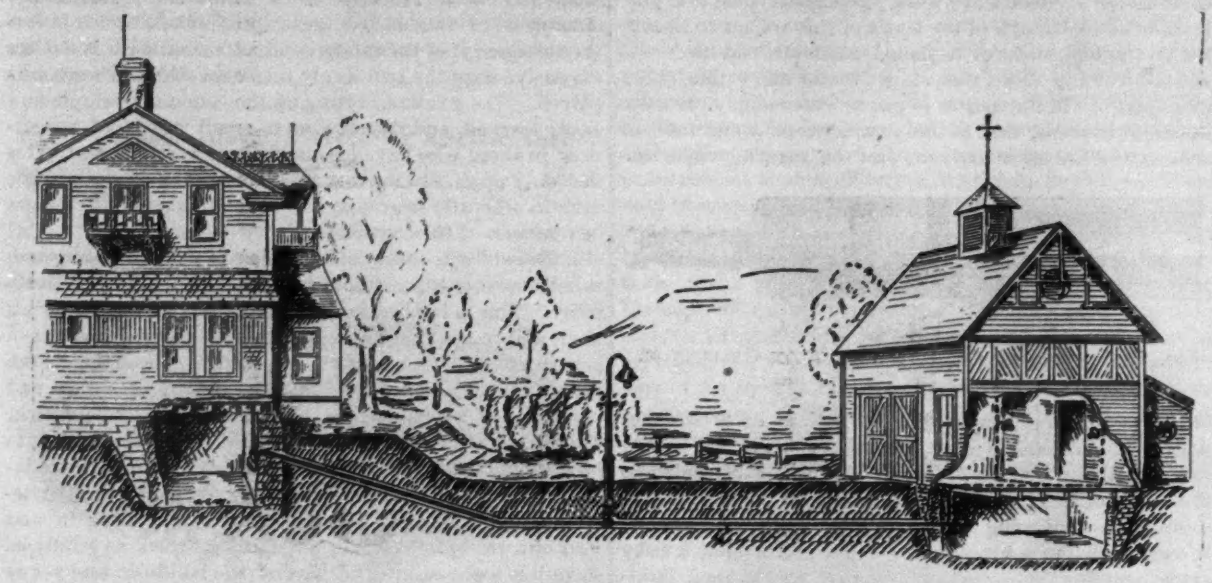


FIG. 6.—CONDUIT FROM HOUSE TO ROAD LAMP AND BARN.

reason exists why the underwriter should lend an ear to any argument save that of absolute safety. With him no pleas of convenience or economy can weigh; in fact, he is apt to regard such recommendations with suspicion if they be not prefaced and reinforced with the vital condition of freedom from danger. Moreover, we find at once the explanation of the frequent reluctance of the underwriter to insure this or that building. The work he is called upon to approve is so bad that he wonders what has become of the contractor's self-respect. It is true that the inspector certifies it, but his heart misgives him, not only as to the risks of "grounds" in the walls and "short circuits" in the moldings, but as to the very nature of the wire that all depends on. Everything is boxed up and plastered up; it cannot be seen in its entirety without worry, expense and great annoyance; and so, after much reflection, he takes the chances reluctantly, with a prayer to the "sweet little cherubs up aloft," not knowing how soon the mistrusted wire may begin eating its own vitals out and then start a fire to conceal its suicide.

Let us compare this with the methods of the Interior Electrical Conduit Company. The tube used is made of a species of paper or papier maché, and combines flexibility with great power of resistance to strain. After it has been made by special process it is subjected to treatment with some secret bituminous, asphaltic compound that renders it thoroughly non-conducting and impervious to moisture. The tube when cut with a knife exhibits every evidence of complete impregnation, and stubbornly resists every attempt to permeate it with water. This tube is made in sizes of ¼ inch to 1¼ inches inside diameter, and in lengths of 10 feet. These lengths are joined together by sleeve couplings and are threaded, and can be right angled or be fitted with elbows for rounding curves and corners. Here at once, in such a tube, we have, beyond the mechanical shield from injury, such a protection against internal or external fire as has never before been provided. Within such a tube ordinary wire may be run with impunity, and whatever may occur the result is confined within the tube. In order, however, to insure positively the operation of the safety devices employed in electric circuits, this conductor is based on the sound, irrefutable principle, that if there is to be a short circuit it were well to have it occur as quickly as possible and within confined limitations. In this conductor, the conductors composed of stranded copper wires are separately insulated, then laid up together and jacketed in a common sheathing of suitable material. Thus, while the wires are normally and properly insulated, there is no absolute bar to a short circuit; but, instead of provocation to slow smoldering, there is an instantaneous compulsion to short circuits and blowing of the safety fuse, so that the trouble must instantaneously declare itself and disappear. The conduits, it may be added, all lead safely and snugly into main junction boxes of metal, while smaller junction boxes, intersection boxes, and outlet terminals make safe, elegant and ample provision for the ramifications and convenience of the service.

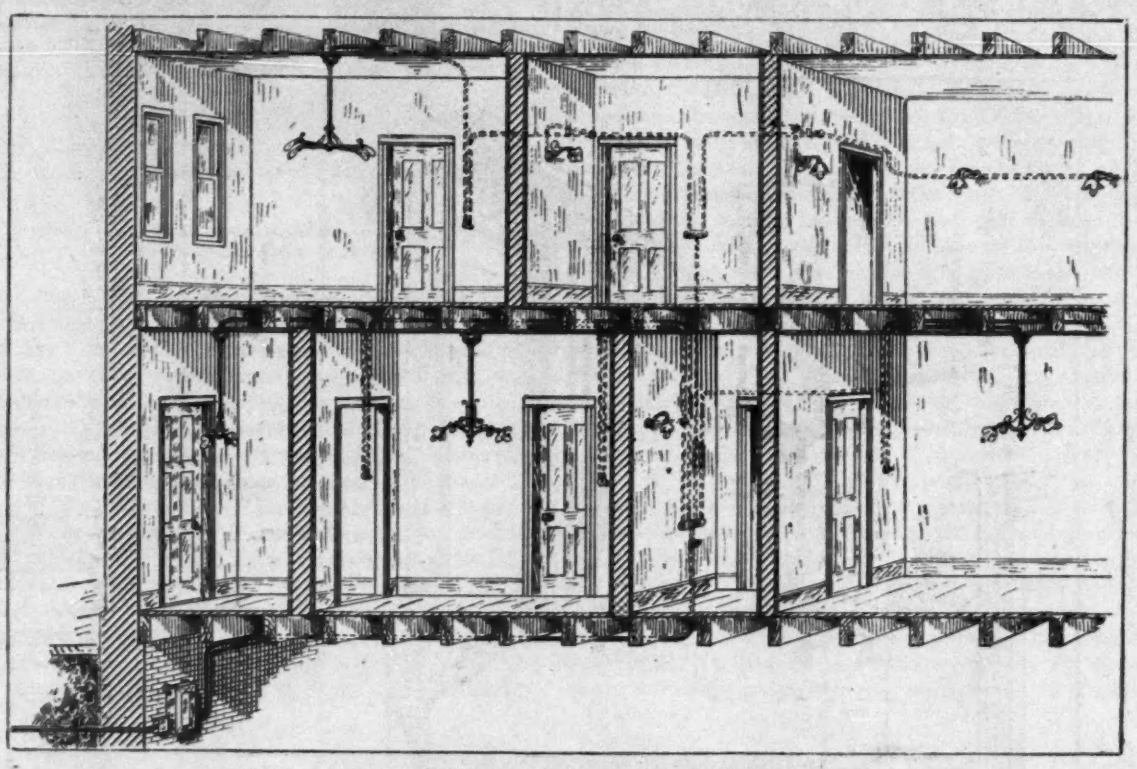


FIG. 7.—STREET CONNECTION AND INTERIOR SERVICE.

FIG. 8.—METHOD OF RUNNING THE TUBE ALONG STORE CEILINGS.

It seems superfluous to point out how superior this method is to anything that has gone before. We leave behind us at one stride all the crude and cumbersome devices of the early stages of the art, and instead of bad work done without plan, and attended by the use of iron staples, wooden moldings and the like, we get a scientific system of predetermined channels, built up of safety tubes, wherein the nature and quality of the wire and its insulation may be immediately and frequently ascertained, and where the use of the safety conductor, practically places a double guard and protection on every circuit. Should the safety fuses fail to act, as they may, and frequently do, in other systems, the safety conductor is there to "watch the watchman" and to repel at once the impending danger. It is impossible, therefore, that the system of the Interior Electrical Conduit Company should fail to receive the hearty indorsement of any insurance expert who has examined and tested it. Its grand, foremost merit is that of safety.

2. *Convenience.*—If we look at any house or building wired on the old plan, we are struck at once with the absence of the element of convenience. If the wire is laid into the plaster, the wiring contractor, in order to guard his work from injury, has to dance a weary attendance on a number of masters and men, whose chief solicitude seems to be that of making his life a burden, and his profit nil. He has no convenience whatever for the execution of the work, which suffers proportionately to the lack of facilities and of close supervision. The same is true of wires run in moldings. Yet in the present condition of affairs one can hardly blame the architect and builder. They know how to deal with a system of gas pipes, steam-pipes, and water-pipes, but when it comes to making provision for wires, which may be led anywhere at the sweet will of the successive persons in charge of an installation, they shirk the job in disgust or despair. But the new system changes all this, as every architect of ordinary attainments is familiar with methods of disposing of piping in his plans. He has something definite to deal with. He can carry the whole system in his mind before he puts a line on paper. He can follow out every part of the distribution in a systematic way, and instead of being repelled by the apparently endless difficulties of electric lighting, is encouraged to make ingenious plans that shall fit the requirements of the case. It is doubtful, therefore, whether the underwriter or the architect will extend the warmer welcome to the system of the Interior Electrical Conduit Company.

Moreover, the convenience afforded is seen again in the ease with which any interference with decorations is avoided. If a building be electrically conduited there is an absolute avoidance of subsequent vandalism in tearing down woodwork, breaking into walls and ruining choice frescoes, papers, or lincrustas. Striking finished examples of the convenient and flexible application of the system are found in the city residence of Mr. J. Pierpont Morgan, and in the new country residence of Mr. Wm. Rockefeller, at Tarrytown. In the former instance, the system of tubing has been installed in substitution of old wiring in such a skillful manner that no trace of its presence can be detected; yet it is so thorough and complete that every foot of wire supplying 600 incandescent lights has been easily inserted and every foot can just as easily be withdrawn, in spite of the many bends and devious turnings that some of the tubes are compelled to take. The gain in this respect over old methods is as enormous as that afforded by a steam track compared with a muddy farm lane in winter, or by an electric over a horse road. It is worthy of note, too, that in the lower servants' hall of the house the tubing has been carried exteriorly along the ceiling from lamp to lamp, and bronzed so that it looks like a handsome run of metal pipe, the real nature and use of which would not be suspected.

In the other example mentioned—the country seat of Mr. Rockefeller—all the wires likewise run through tubing, from the cellar to the topmost room and outlook; and the changes of architectural plan or decorative effect made

from time to time in the course of interior construction have been skillfully and promptly met, as they could be in no other way, by a redisposition of the conduits. One novel piece of work is that connected with a massive stone driveway or approach. Along the buttressed wall are placed posts for incandescent lamps, and each of these is reached through long sections of the conduit that lie in the channeled parapet. Thus right in the solid stone masonry is an element-tight conduit, through which, controlled from the house, the wires run out of sight, yet immediately accessible for inspection, repairs or enlargement.

Reference has been made above, in passing, to the definiteness given to plans for wiring. In this connection, under the head of "Convenience," mention must be made of the basic principles adopted. These are the subject of a broad patent, and belong to the scientific evolution of the art of electrical distribution. A common practice in wiring large buildings, has been to adopt the "circulation" method, which consists broadly in running the main conductor clear through from the dynamo to the last floor, and taking off a feeder at each floor to supply the lamps. There are many objections to this method, such as drop in voltage, increase of heating in the wires, abnormal breakage of lamps, and a general uncertainty as to the location of the controlling points of the system, so that "cut and try" methods often result in sorry work when testing out trouble becomes necessary. In the "distribution" method which is employed by the Conduit Company under its patents, everything is worked out scientifically and systematically, and the various parts fall into their places like the different divisions of a well organized machine. The "distribution" idea is to wire to centres, or distributing points midway in the installation, so that, starting with the main feeders, the whole system, down to the last lamps, is one of equalized pressure, perfect balance, and, therefore, of successful working. As a natural corollary of this method, the junction boxes, switches, cut-outs, etc., which are all of handsome design, find convenient, and presently familiar, places on each floor, under lock and key if desired, but as easy to reach as the hat-rack or the water-cooler. It follows also that all branches and taps, in such a system, are taken off in definitely ordered places and at a right angle or curve, and do not run, as they so often have, in such a manner as to suggest that the object of the wireman was to lose all track of their location. No system will long prevail unless it is right in conception and systematically carried out. The "distribution" idea confidently claims this distinction.

3. *Accessibility.*—The system of the Interior Electrical Conduit Company is pre-eminently one which provides for the future; in fact it is unique in this respect, as there is no other that does. The absence of this quality in previous methods has been one of the drawbacks of electrical work generally, but the public now know enough of the needs of the art not to be misled by the sophistries of exploded methods, and they will not allow it any more than they would allow like pernicious practice in the matter of gas or water supply. It is too apparent to them, that in the new system every inch of wire can be drawn in and out, and the carrying capacities

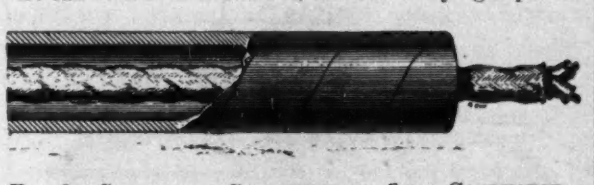


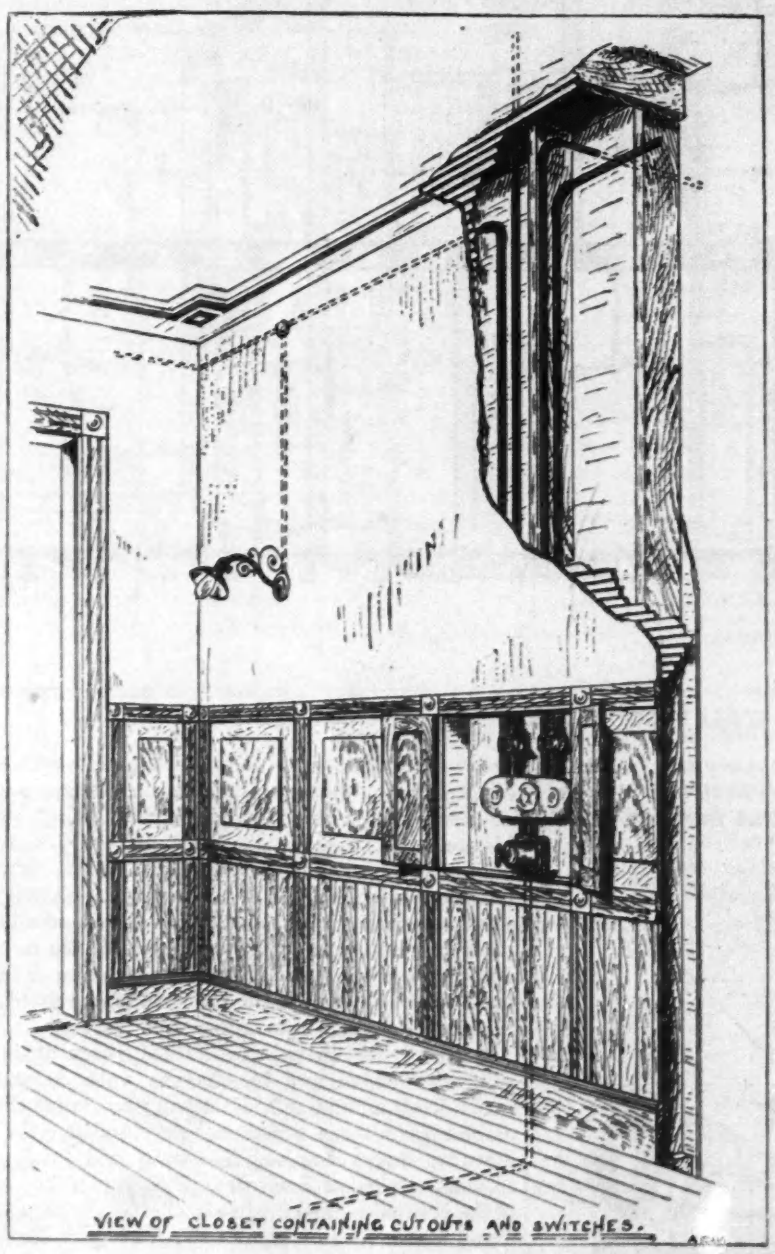
Fig. 9.—Section of Conduit with Twin Conductor.

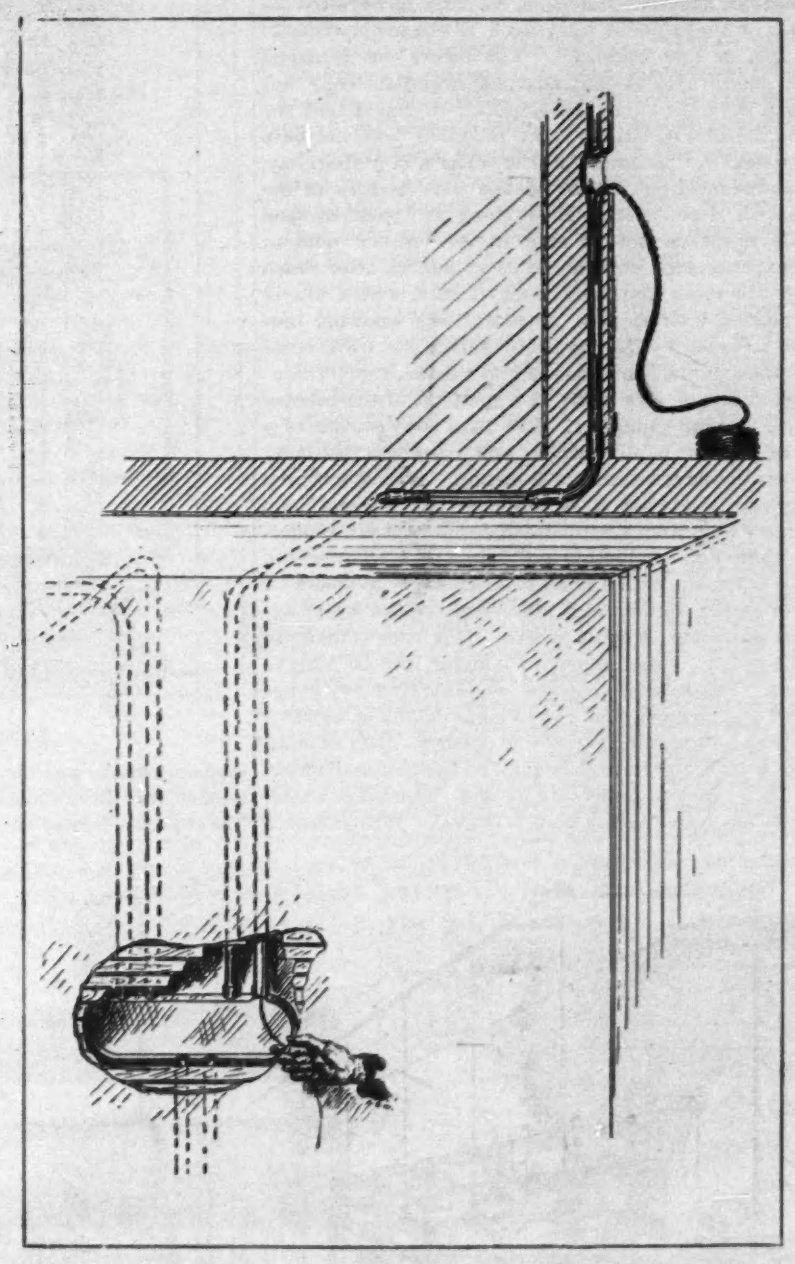
of the circuits be increased at any time in accordance with the requirements of a tenant or with any other exigency that may arise. Nor is this all. Hundreds and thousands of fine houses and buildings in all parts of the country are now going up remote from centres of supply. It seems a shame not to wire them, yet it is not less a risky extravagance to do so unless they are within some lighting area where the light is immediately available. The result is that in the vast majority of instances they go unwired, and the very fact that they are thus unprovided with wires is a hindrance to the adoption of the light when the opportunity for obtaining it actually arrives. Now, with the adoption of the system in question, any new building can be supplied with its interior conduits at a mere nominal cost, and thus be placed in condition to receive the wires without annoyance or delay when the boon of incandescent lighting is within reach. In these days of rapid development in electrical enterprises, this moment is apt to come sooner than the builder has anticipated, and it is extremely important, not only to him but to the local electrical service companies, that this preliminary step should have been taken. To many a householder and owner of large edifices, the mere knowledge that these buildings are conduited, and that the wires can be drawn in at once without trouble or damage to the property, will be an inducement to the introduction of the new illuminant.

4. *Economy.*—One of the first questions asked with regard to improvements and new apparatus is, "What will it cost?" Happily this question is one that can be most satisfactorily answered in behalf of the system of the Interior Electrical Conduit Company. The material of which the conduit is composed is of the most inexpensive character, and the processes to which it is submitted have already been so ingeniously worked out that the element of labor has been reduced to a minimum. Hence the conduit is of established cheap production, and it is further claimed that the safety conductor used with it is less expensive than the two singly insulated wires hitherto employed. The work of putting up the conduit is simple and easily learned, and requires but a small degree of expertness in those who have to insert the wires in them. This not only applies to the original work of installation, but even in a greater degree to the work of subsequent changes or renewals of the circuits.

5. *Durability.*—Many of the points of value in the system sum themselves up in the great recommendation of durability. This is implied in the very nature of the materials used, and in the broad idea of the system, which offers a permanent enduring conduit into which, to-morrow or ten years hence, with equal freedom, safety, economy and convenience, a complete set of conductors may be drawn. The permanence of the wires themselves is also added to immeasurably, for they are protected from mechanical injury as never before, and are also exempted from the deteriorating effects of moisture, gases, etc. Year in and year out, the system will go on doing its work as solidly as though it were an integral part of the building, and yet so accessible that in a moment any wire at any point in the whole network may be reached for ocular inspection.

A system so flexible as this is capable of a variety of applications, and some of them are illustrated herewith as examples. The conduit itself is also susceptible of ornamental treatment, if necessary, and may be painted or even electro-plated in any metal, and remarkable decorative effects produced. It is noteworthy, too, that the conduit possesses marked advantages as a speaking tube, and that in this department alone it is expected to gain pre-eminence, being cheaper than metal, and at the same time being perfectly smooth inside and free from the seams and joints that impair the transmission of sound through metal tubes.





FIGS. 10 AND 11.—SWITCH CLOSET AND METHOD OF DRAWING IN WIRE.

The Relation between Magnetic Disturbances and Earthquakes.

In a note in a recent number of the *Comptes Rendus*, M. Mascart reports that M. Moureaux, who has charge of the magnetic observations at Saint-Maur, has informed him that the magnetic curves for Oct. 25 show indications of disturbances similar to those which have previously been noticed on the occasion of earthquakes, although on that day a copper bar attached to a bifilar suspension did not show the slightest deflection. Since this the papers have

announced an earthquake which caused considerable destruction at Gallipoli, and which, from all accounts, seems to have taken place at the moment when the magnetic disturbances were observed at Saint-Maur. If further information confirms the simultaneity of the two events, it would seem that the disturbances of magnetic instruments are not due—in some cases, at any rate—to the mechanical transmission of the shock.

Cutter's Combination Tin Shade for Electric Lamps.

Our engravings, Figs. 1 and 2, represent a new combination tin shade recently brought out by Mr. George Cutter, of Chicago, which obviates some of the inconveniences attached to the independent shade, as usually combined with the shade-holder. The shade illustrated is

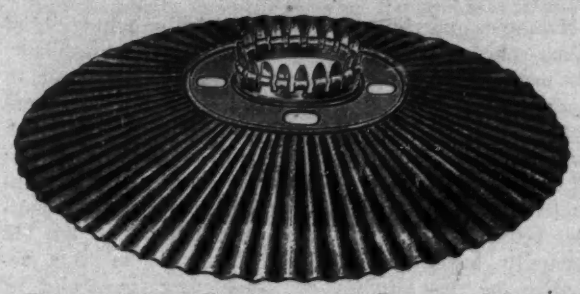


FIG. 1.—CUTTER TIN SHADE FOR ELECTRIC LAMPS.

made of corrugated tin, bright at the bottom, so as to give a good dispersion of light, and green on top. The shade-holder is firmly fastened to the socket and therefore always hangs square with respect to the lamp, and without the aid of screws now generally employed. The illustration, Fig. 2, shows the shade attached to a lamp. As will be readily understood, the device is especially adapted for mills, factories, stores, etc., and, indeed, is useful wherever shades are liable to be broken.

The Easton System of Electric Lighting.

For several years past a system of electric lighting has been exploited in Canada under the name of the "Reliance" system. It is the invention of Mr. James W. Easton, and as lately improved is now being introduced in this country by the Easton Electric Company of this city, and possesses a number of novel features.

Beginning with the dynamo, which is illustrated in the engraving, Fig. 1, one of its special features is the arrangement for preventing burnt-outs from abnormal current, due to short-circuiting on the external circuit or at the commutator. In the usual form of Gramme ring machine, connection is made at the point of contact with the commutator, and any breakage of the wire forming the connection opens the circuit in the armature and stops the flow of current. In the Easton system the connection is made by a firm, soldered joint at the surface of the armature itself, and the wires are supported and prevented from accidental injury, equally with the remainder of the wire which composes the winding. These joints are at exactly equal distances apart, and form convenient points for making connections between the armature and the commutator; but as may readily be understood, a rupture or breakage of such connectors will not open the circuit of the armature, which is closed independently of the armature, or the connectors, but will simply reduce the number of points at which connection is made with the armature circuit. In other words, if every alternate connector, in an armature of 120 sections, were to break, the result would only be that the same amount of armature wire would be divided into 60 sections instead of 120. Having produced an armature in which the rupture of the connectors would not appreciably interfere with the operation, the next step was to design and locate connectors in such a manner, that any short circuit occurring in the commutator would cause a rupture of the connector corresponding, and thus stop instantly the flow of the abnormally great and destructive current that would otherwise circulate in the short-circuited section of the armature.

As a connector that would rupture with certainty upon a short circuit occurring in the commutator, a fusible metal was chosen, which is also springy, and which is made to assume the form of a spiral spring, thus becoming a flexible connector which is not likely to be broken by vibration. This fusible metal wire is of such a size that the resistance for any given length is about one-eightieth of that of the copper wire employed in the armature. The arrangement is such, however, that these fusible wires are only in circuit when the collecting brush is in contact with the corresponding segment in the commutator, as at all other times the current flows to the joint between the sections, where it enters the next section without passing through the fusible connectors. Thus the fuses are only carriers of current for one-sixtieth part of the time on an armature of 120 sections (one-one hundred and twentieth part of the time on each brush contact), and have the entire remaining time for radiation and convection of the heat produced. As the fuses are one-eightieth of the conductivity of the armature wire, this would result in the fuses being more heated than the wire of the armature;

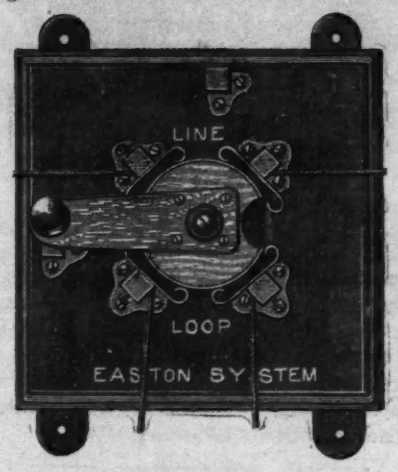


FIG. 5—SWITCH, EASTON SYSTEM.

but the fuse is more exposed to cooling influences, and this equalizes the actual heat attained in normal operation. But if, for any reason, a short circuit should occur in the commutator, the current that flows through that section of the armature must also pass continuously through the fuses in order to pass through the short circuit, and with the normal current flowing through the short circuit the heating effect would be sixty times the normal amount on the fuses.

As will be readily seen, the fuses melt almost instantly under these conditions, and the centrifugal force throws the melted metal away from the machine entirely. This leaves two blocks in the commutator connected together as one, and two corresponding sections in the armature acting as one section of double the size. This device, therefore, accomplishes instantly and automatically just what a first-class machine attendant would do, if he could not find the short-circuiting matter and without stopping the machine, as he would be compelled to do even if he knew of it when the short circuit formed. There is no need to stop the dynamo, as it is almost impossible to tell whether a few fuses are out, or if all are in. When the attendant notices a fuse gone he can look up the short-circuiting matter and remove it at his leisure, then replace the destroyed fuse and all is once more in perfect order.

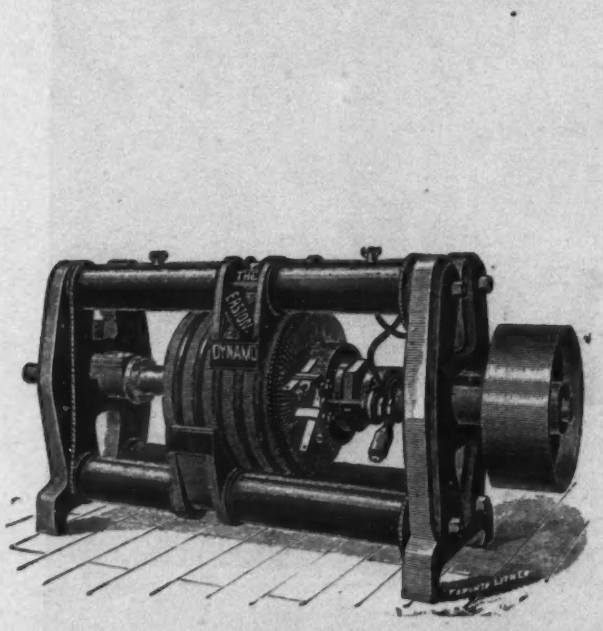
In order to avoid the difficulty frequently experienced in the loosening of the armature parts, shifting of the wire and consequent abrasion to the insulation, Mr. Easton has adopted a special construction of the armature. Thus, the shaft of the dynamo is a large screw-bolt that draws all the running parts firmly together. The normal strain of driving the armature keeps the shaft perpetually screwed tightly. In accomplishing this result a simple contrivance is used, consisting of a collar on the shaft, and integral therewith, which acts as a head of a bolt. On the shaft, and against this collar, the hub of the commutator is placed and is left free to rotate on the shaft. The rear end of this hub is nearly as large in diameter as the inside diameter of the armature. Against the rear end of the hub abut a series of wooden blocks, which are turned outside to the interior diameter of the armature, and are bored out tapering or cone shape. Feathers on the

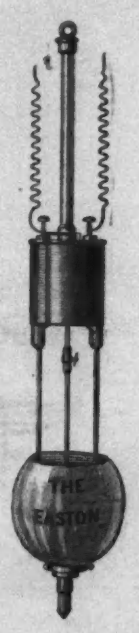
FIG. 2.—CUTTER TIN SHADE FOR ELECTRIC LAMPS.

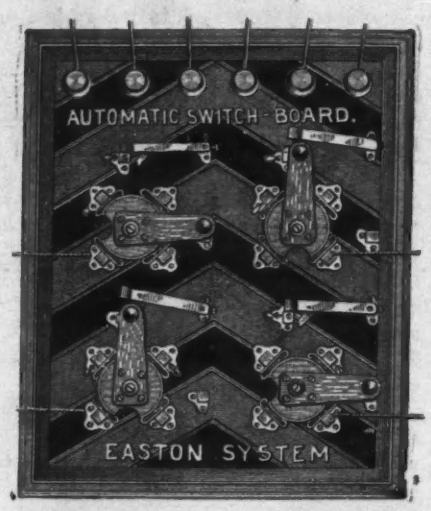
hub keep the blocks from relative rotary motion, though allowing a radial movement of the blocks. This prevents any relative rotary movement of the armature which is carried on the series of blocks, and yet allows the blocks to expand and grip the armature more firmly if necessary. To cause these blocks to expand and grip the armature, a cone of brass is fitted to the screw-thread on the shaft, and the strain of driving the armature causes the cone to rotate on the thread, moving along the shaft into the blocks, which cannot move laterally, as they abut against the hub of the commutator, which in turn abuts against the collar of the shaft. The only way the blocks can move is outwardly, and this they do until the strain of driving the armature prevent the cone from moving further, since the blocks now press it and the inner surface of the armature firmly, and prevent the cone from entering further. The whole now revolves with the shaft until for some reason, such as shrinkage of insulator, the blocks loosen sufficiently to allow the whole to rotate on the shaft and draw the cone in further, thereby expanding the blocks and "taking up" the looseness. It is hardly proper to describe the action as if looseness actually occurred, as the cone is continually being forced in, and looseness is never possible. Observation shows that the shaft makes about one revolution in ten millions more than the armature, commutator and mounting during the firs fifty million revolutions, and after that very little relative movement can be detected, as everything has come to a solid bearing. For the purpose of ventilation the cone has a row of holes drilled opposite to the separating spaces between the blocks and the exterior surface of the blocks is deeply grooved in a spiral direction, thus forming a rotary blower that forces a blast of air along the interior surface of the armature, and keeps it as cool as the exterior surface, which is exposed to the air.

One of the peculiar features of the machine is the arrangement of the pole pieces, which are placed in an oblique position over the centre of the armature, in order to decrease the leakage from pole to pole through the "atmospheric field" by increasing the distance from pole to pole to the greatest practicable extent.

Among the minor details of the dynamo may be noticed the construction of the commutator, in which is turned a deep groove at the extremity of the wearing surface, which enables the attendant to keep his brushes constantly out to the edge of the commutator on *both* sides, thus avoiding the wearing of gutters or ridges around the commutator.







FIGS. 1, 2, 3 AND 4.—DYNAMO, LAMP AND SWITCHES, EASTON ELECTRIC LIGHTING SYSTEM.

The wearing depth provided in the 20-light dynamo is 1¼ inches and the width two inches. The brushes are one inch wide and run alternately, first on one edge and then on the other, of the wearing surface.

The field coils are subdivided into eight separate parts, with the result of attaining a greater surface for radiation of the heat produced. Moreover, in case of accidental injury to a coil by careless handling, the remaining seven are usually sufficient to operate the machine in a more or less perfect manner until a new coil can be placed or the old one repaired. The coils are wound on spools, and can be removed from the bars entire. The coils are connected to each other by firmly-soldered joints, and all are connected into the circuit as a single coil would be. The coils are connected at the point where the current enters the machine, and consequently the insulation of the field coils is under little or no strain.

The shaft is large and the bearing surfaces are long and ample, being 10 inches long and 2 inches diameter for a 20-light dynamo. The bearings are self-aligning and amply ubricated, carrying a supply of lubricant sufficient for a week's steady running under ordinary conditions. The shaft is of machine steel, and the bearings have gun-metal bushings, which slide into iron shells, and automatically lock themselves from rotation when they are slid home.

The pole pieces and end frames are of cast iron and the pole pieces are cast upon and embrace the magnet bars, which are round bars of cold-rolled soft wrought iron.

The low tension dynamo and motor are constructed on lines quite similar to those of the machine just described.

The arc lamp used in the Easton system, and shown in Fig. 2, has a novel movement invented by Mr. Easton. It is a rack and pinion lamp, but has no further gearing. The escapement wheel is on the same shaft as the pinion and integral with it in motion. The escapement is placed in a pivoted frame similar to the Hefner-Alteneck movement, and is controlled by two magnets having the same general appearance as those of the Hefner-Alteneck, but differently wound and connected. The escapement pallet has a movement from a very slow feed motion to one gradually increasing to a very fast feed or even a free descent of the rod uncontrolled by the pallet. The cut-out contact is solely governed by the movements of the oscillating frame, and only operates to cut out the lamp if the carbon fails to feed after about four or five times the proper interval of time.

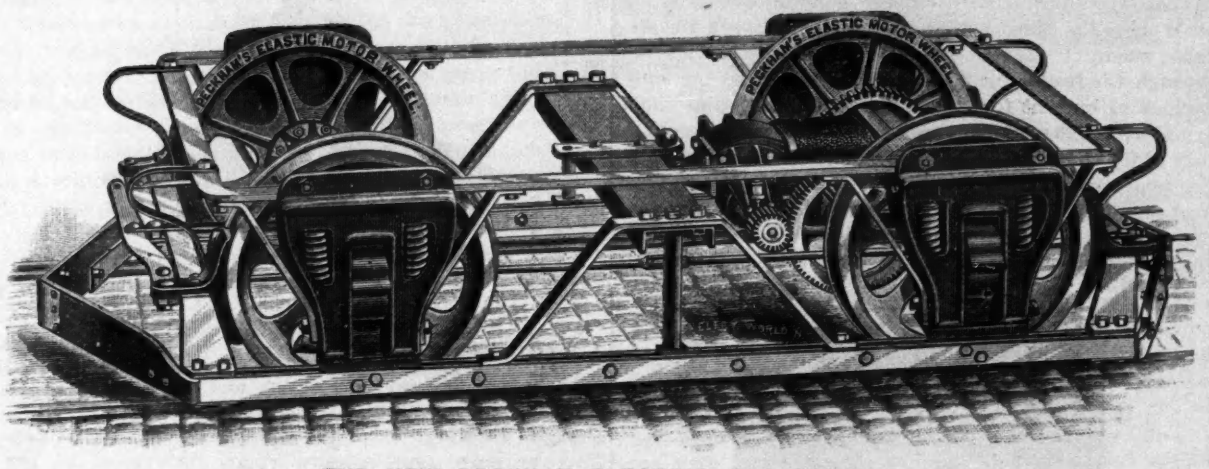
The adjustment is confined to a single screw, which is operated by the fingers, and by means of this one screw the lamp may be adjusted to burn any length of arc from $\frac{1}{32}$ to $\frac{1}{4}$ inch if desired.

The standard indicators used in the Easton system are an ampère meter and a voltmeter, which have a limited reading at the most sensitive part of the swing. They thus give very distinct readings for very small changes in the current or potential.

The switch board employed in this system possesses several novel features. In its simplest form, as designed for one dynamo and one circuit, Fig. 3, it consists of four binding posts, carrying spring contacts, and arranged at four equidistant points from a common centre. A disc having a free rotary movement of one quarter of a turn bears two conductive strips, which are adapted to make the desired connections among the binding posts, and also a projection adapted to operate an automatic switch which serves to place the field coils in or out of the circuit as required. If the machine is disconnected from the circuits the dynamo is on a short circuit, and the automatic switch will place the field coils out of the circuit. In this case the machine will generate no current, as there is no exciting force applied to the field magnets.

The first result of rotary movement of the disc is to connect the dynamo to the circuit, but not into it, as the dynamo and work circuits are still closed independently of each other. A further movement of the disc connects the dynamo into the work circuit, and the circuits are no longer closed independently of each other. A further movement of the disc, by means of the projecting part, operates the automatic switch lever and connects the field coils into the circuit, and, as the exciting force is now applied to the field magnets by means of the coils thereon, the dynamo now begins to generate a current through the circuit. If desired, other circuits may be connected in, with or after the first one, or in like manner other dynamos may be "coupled" on the same circuit or other circuits by providing for each the necessary switch. In the reverse action the field coils of course are automatically cut out of the circuit first, and afterward the circuit is disconnected from the dynamo and left closed past the dynamo circuit and totally removed from any connection thereto. If switches for other dynamos are included in the same work circuit, any of the dynamos may be switched into such circuit. Connections of improper polarity are thus impossible, as connections can only be made in one manner. The engraving, Fig. 4, shows an automatic switchboard arranged for a number of circuits.

The loop switch and door cut-outs, illustrated in Fig. 5, are based upon the same principle of action, but have no automatic switch, as it is not necessary.



THE NEW PECKHAM ELECTRIC CAR TRUCK

Peckham's New Electric Motor Truck.

Our readers will remember that some weeks ago we described and illustrated in our columns a new form of motor truck designed by Mr. Peckham, and manufactured by the Peckham Street Car and Axle Company, of this city, and specially adapted for the work for electric street cars. Among the prominent and novel features of the truck described was the suspension of the motors from the top of the car frame instead of supporting them on crossway angle irons attached to the bottom of the truck, as in the earlier forms, the advantage of this new method of suspension being that the motors can adjust themselves to curves and grades without severe strain being put upon the gearing, and also the introduction of a bridge truss to support the side frames. In the accompanying illustration is shown a further improvement introducing a modification of the first truck. In the first form the motion of the car frame might tend, if violent, to jar and injure the motor and gearing. To overcome this possibility, the separation of the motor and car frame has been effected in the following ingenious manner:

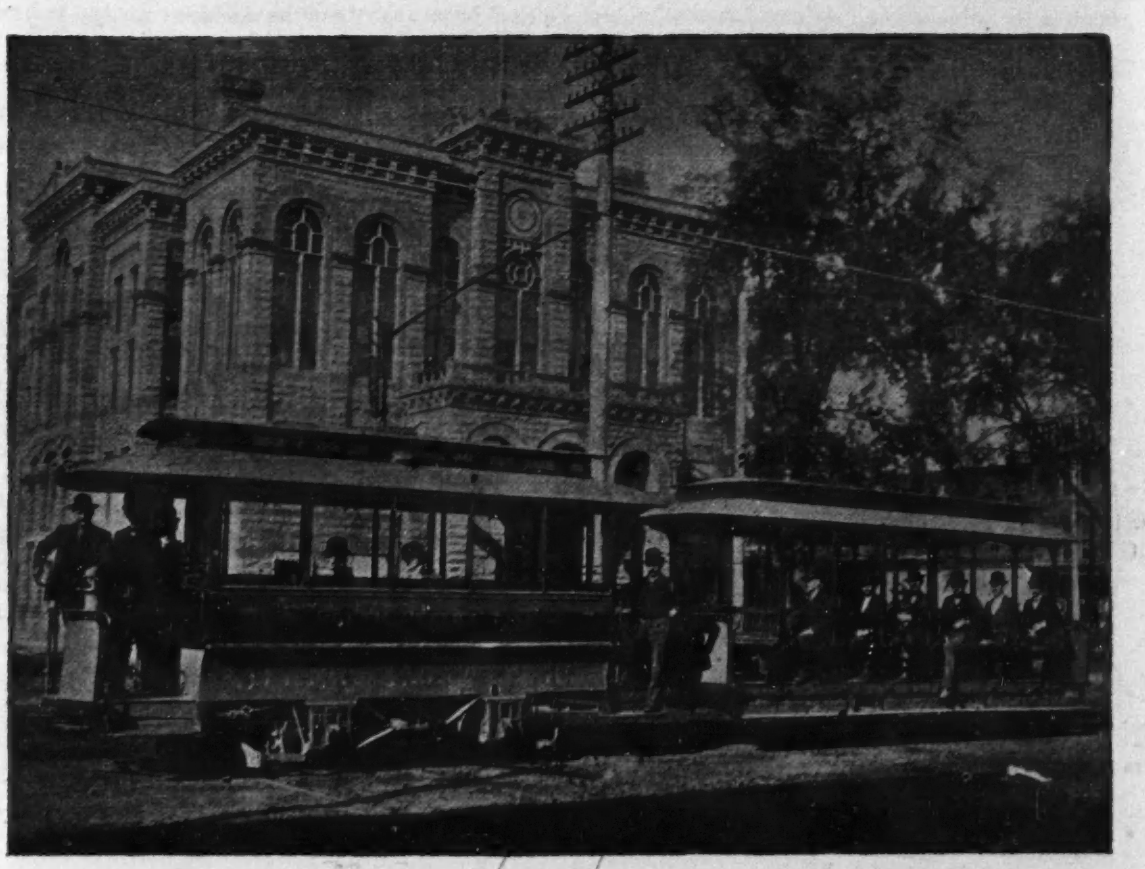
The bar which carries the snow plow and the motor support is directly suspended over the axle-box by means of a special form of pedestal, and the bridge truss is attached to this bar, and not connected in any way with the top of the truck, in such a manner that the motor is prevented from swinging with an up and down motion, in accordance with the movements of the car frame as it would do if rigidly joined to the frame of the truck. At the same time easy access is given to the motors and gearing, thus facilitating examination of the same and repairs when necessary. The car frame proper, as will be seen in the cut, is thus perfectly distinct from the motor supports and guard rail, giving an easy action to the car body, while the conditions are such that the motor adjusts itself to the direction of the wheels and axles while rounding curves, and prevents any undue strain on the working parts.

The Electrical Conductivity of Saline Solutions.

Numerous experiments on the electrical conductivity of saline solutions have been made by M. P. Chroustchoff. The methods were applied to mixtures of different salts in equivalent proportions. The conclusions arrived at are as follows: (1) Starting with any system of two salts, the same conductivity is obtained as with the inverse system; (2) the conductivity of the mixture is not the mean conductivity of either system of two salts, nor is it intermediate between the two mean conductivities, but is generally lower than either. This points to a reduction in the number of conducting molecules in the liquid, or, in other words, to the formation of double salts. The typical reaction as represented by the ordinary equation for double decomposition is rarely met with, and in almost all cases the change is complicated by secondary reactions. Other experiments were made with mixtures of two salts which were not likely to interact. The conductivity of each solution was determined separately, and they were then mixed in equivalent proportions. In some cases the observed conductivity of the mixture is the mean conductivity of its constituents; in another case it is lower. It follows that with the degree of dilution employed there is a reduction in the number of conducting molecules, either by formation of double salts, as with some of the sulphates, or by dissociation by the water, as in the case of zinc acetate. The *Journal* of the Chemical Society points out that it is noteworthy that, as a rule, mixtures of salts which crystallize with water have the mean conductivity of their on stituents, while the conductivity of mixtures of salts which form anhydrous crystals is below the mean.

The First Electric Road in the State of Illinois.

The first electric railway built in the State of Illinois is shown in the accompanying cut. It was constructed by the Thomson-Houston Electric Company, under their well known system, and has been in operation, at Ottawa, Ill., since Aug. 15, 1889. The length of the road, including the turnouts, is six miles of single track. The overhead construction has been used throughout. The cars are twelve in number, four equipped with two 15 h. p. motors each, and eight with two 10 h. p. motors each.



THOMSON-HOUSTON ELECTRIC RAILWAY AT OTTAWA, ILL.

The power plant for supplying the necessary current for the cars consists of a 200 h. p. engine, with necessary boilers, and two 80 h. p. generators, with complete station fittings. It has been frequently said by those who have witnessed the workings of this road, that if all the electric railways installed in the State subsequently work as well as this one has, the State will not want for efficient street car service.

Electric Lighting in Berlin.

It is now proposed to permit the Berliner Elecktricitaets-Werke to install its mains outside of the territory already granted to it. Even at the present time the company is not able to furnish current for all that demand it, and constant additions are being made. The amount of current which the stations are able to furnish may be estimated by the number of horse power of the stations. Thus the station at Nos. 43–44 Markgrafenstrasse is now operating with 3,480 h. p.; that at No. 80 Mauerstrasse, with 5,240 h. p.; and at No. 85 Friedrichstrasse, with 300. The new station at No. 49 Spandauerstrasse will be opened with 2,000 h. p., but is designed for an eventual capacity of 4,000 h. p. Finally, the station at the Schiffbauerdamm, now in course of construction, is designed for 10,000 h. p., and in order to meet the growing demand it is proposed to increase this to 15,000 h. p. Thus the total horse power devoted to electric incandescent lighting by this company will alone amount to 28,000.

The year ending June 30th showed 46,710 incandescent lamps connected to the circuit, which had aggregated a total of 25,907,360 lamp-hours; and to this must be added 144 arc lamps for street lights, which had burned in the aggregate 333,591 lamp-hours.

We have before us the annual report of the company, ending June, 1889, which shows their business to be in the most thriving condition. After making allowances of 5 per cent. to the reserve fund, for renewal account, depreciation, interests and donations to the officials and to the sick fund, a dividend of 8 per cent. was declared on a capital of 3,000,000 marks.

The Bundy Electric Cash Register.

Retail dealers in all kinds of wares are becoming more and more alive to the value of having a register of the amount of each purchase made by customers, not only as a check upon their employés but as a matter of convenience in keeping their accounts. A novel cash register of this description has recently been brought out by Mr. Willard L. Bundy, superintendent of the Bundy Manufacturing Company, of Binghamton, N. Y., which is illustrated in the accompanying engraving.

One of the principal advantages of this register is that it can be worked as readily with one hand as with two. As will be seen, the upper row of keys represents dollars, the next row dimes, and the lower row cents.

If the amount desired to be registered is, for instance, $7.91, one first presses on the key in the dollar row marked 7, then in the dimes' row on the key marked 9, and then in the row of cents on the key marked 1. The drawer of the register will not open until the key of the cents column is

THE BUNDY ELECTRIC CASH REGISTER.

touched, when the drawer immediately opens and rings a bell.

In the machine represented in the engraving there is an extra row of keys in series of five cents up to one dollar. If the amount comes within this five cents series, the single key in the combination will register it and open the drawer. When the drawer is pushed in after the requisite amount of cash is deposited, it must be wholly shut and locked, otherwise a bell will ring until this is done. Besides, the drawer cannot be pulled out, after attempting to close it, until it is fully closed and locked; thus carelessness in closing the drawer is at once detected.

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At the close of business the door in the front of the register is dropped, and on the dials is noted the total cash of the day in dollars, dimes and cents, so that the total amount of the day's business can be seen at a glance.

The amount which this machine will register can be extended at a slight expense to any limit, and therefore it will undoubtedly prove valuable to banks and other institutions where large amounts are generally noted down, and the computation of the gross amount must be correctly indicated at the close of the day's business.

This door in front exposing the adding device cannot be tampered with or opened without detection, thus giving no opportunity to change the amount of the total registration. On opening this door a paper is punctured so as to show the date when unlocked and opened. This will be readily seen to be a valuable precaution against fraud and imposition.

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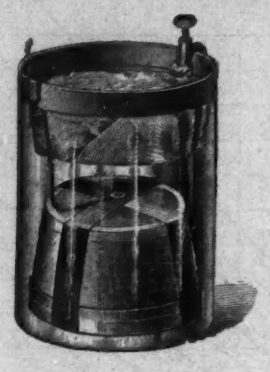

IMPROVED GRAVITY BATTERY.

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Note on a New Gravity Cell.*

BY P. B. DELANY.

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In a battery of any considerable number of ordinary cells, it would be difficult to find two alike in this respect. There is little or no stalactite formation from the zinc, and consequently no local action, rendering the battery very useful for open circuit work. When water is poured in to make up for evaporation, the equilibrium of the fluids is not disturbed. The deposit on the zinc thus protected is easily removable, requiring no hacking or scraping. One zinc will endure two charges of sulphate of copper.

The band around the rim is one of the most important features of the cell, as it prevents zinc sulphate from creeping over. It offers simply a mechanical obstruction. It works perfectly in practice. Of course these strips or bands may be applied to any battery requiring them. They serve equally well for a Leclanché battery, and to attach them to cells of any kind already set up it is only necessary to see that the rims of the jars are clean and dry. The sticky side of the strip should be heated slightly and pressed on firmly all around.

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This stair climber consists of three parts. The first of these is the guide, which consists of two parallel flat iron rods supported on the balustrade; second, a movable platform, which is supported by and guided by the rails; and third, a motor. The motor, it will be seen, is an electric one which acts directly upon a windlass, to which a chain is attached which pulls up the platform upon which the person stands. Each of these little elevators from story to story is independent of the other, so that one person might be ascending from one story to another while the other is descending.

The motor can be made to turn backward or forward, or to stop at will, by the person on the platform, by the simple movement of a small switch connected to the motor by flexible conductors, and by which the current is reversed in the armature without changing the position of the brushes. The magnets are fed by a special shunt, in which the current is always in the same direction. In this way the motor may be turned in either direction for rising or descending.

The design of this elevator is due to M. J. Alain Amiot, and, with the ready method of distribution of power afforded by the electric current, ought to find many applications in private houses.

AN ELECTRIC STAIR CLIMBER.

* Read before the American Institute of Electrical Engineers, New York, Nov. 19, 1889.

On the Heating of Conductors by Electric Currents.

BY A. E. KENNELLY.

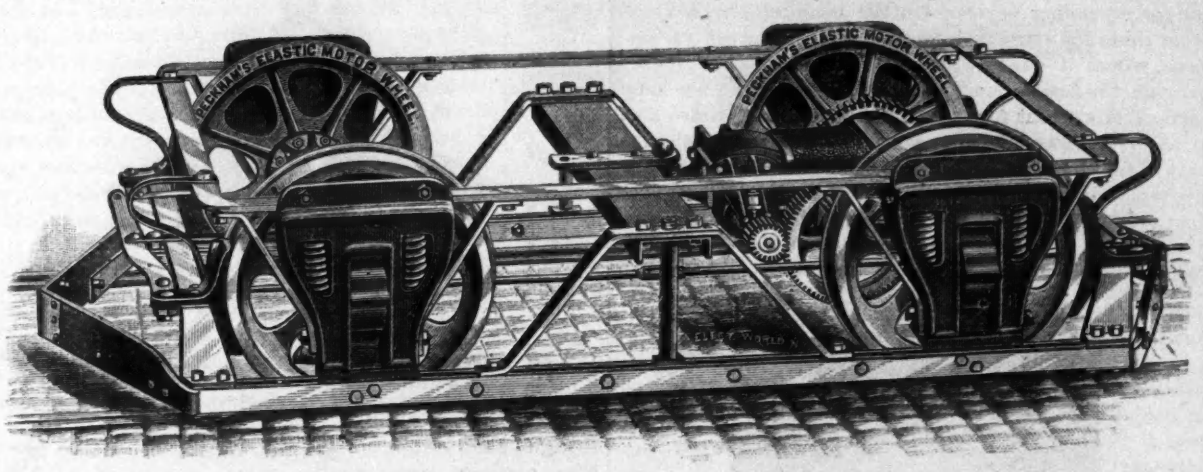
II.

The accompanying diagram, Fig. 4, shows the curves obtained by freely connecting the plotted observations resulting from the whole series of panel measurements. The ordinates represent the temperature elevations and the abscissas are the current strengths to which those temperature elevations are due. Of the three connected variables, diameter, current strength and rise of temperature, this figure most clearly indicates the relation between temperature and current, while the influence of diameter may be deferred for the moment. It is seen that, generally speaking, the temperature elevation varies as the square of the current strength for any given wire. This would be, perhaps, rigorously true if the resistance of the wire did not increase with temperature, if the conductivity of the panel remained constant, if the space between the wire and the panel walls were filled with solid material, and finally if the exterior surface of the panel were maintained at the temperature of surrounding bodies. Under existing conditions the wire generates heat—owing to its rising resistance—faster than the square of the current; while, on the other hand, radiation and convection from the external surface are more than proportionally active as the temperature rises, the two deviations thus counteracting to some extent. So that while the above law cannot be expected to apply accurately, the observations show the departures from it are not so great as to make the rule practically unserviceable. For diameters below 0.10 inch (0.25 centimetre) the temperature elevation appears to have risen more slowly than the square of the current, while for diameters above 0.30 inch (0.76 centimetre) the opposite tendency is shown.

On plotting the results of Fig. 4 in such a manner as to elicit the dependence of temperature elevation on diameter alone for constant current strengths, the curves so obtained have not been identified with any simple algebraic law; in fact the conditions are of so complex a nature as to afford

The wearing depth provided in the 20-light dynamo is 1¼ inches and the width two inches. The brushes are one inch wide and run alternately, first on one edge and then on the other, of the wearing surface.

The field coils are subdivided into eight separate parts, with the result of attaining a greater surface for radiation of the heat produced. Moreover, in case of accidental injury to a coil by careless handling, the remaining seven are usually sufficient to operate the machine in a more or less perfect manner until a new coil can be placed or the old one repaired. The coils are wound on spools, and can be removed from the bars entire. The coils are connected



THE NEW PECKHAM ELECTRIC CAR TRUCK

to each other by firmly-soldered joints, and all are connected into the circuit as a single coil would be. The coils are connected at the point where the current enters the machine, and consequently the insulation of the field coils is under little or no strain.

The shaft is large and the bearing surfaces are long and ample, being 10 inches long and 2 inches diameter for a 20-light dynamo. The bearings are self-aligning and amply ubricated, carrying a supply of lubricant sufficient for a week's steady running under ordinary conditions. The shaft is of machine steel, and the bearings have gun-metal bushings, which slide into iron shells, and automatically lock themselves from rotation when they are slid home.

The pole pieces and end frames are of cast iron and the pole pieces are cast upon and embrace the magnet bars, which are round bars of cold-rolled soft wrought iron.

The low tension dynamo and motor are constructed on lines quite similar to those of the machine just described.

The arc lamp used in the Easton system, and shown in Fig. 2, has a novel movement invented by Mr. Easton. It is a rack and pinion lamp, but has no further gearing. The escapement wheel is on the same shaft as the pinion and integral with it in motion. The escapement is placed in a pivoted fra ne similar to the Hefner-Alteneck movement, and is controlled by two magnets having the same general appearance as those of the Hefner-Alteneck, but differently wound and connected. The escapement pallet has a movement from a very slow feed motion to one gradually increasing to a very fast feed or even a free descent of the rod uncontrolled by the pallet. The cut-out contact is solely governed by the movements of the oscillating frame, and only operates to cut out the lamp if the carbon fails to feed after about four or five times the proper interval of time.

The adjustment is confined to a single screw, which is operated by the fingers, and by means of this one screw the lamp may be adjusted to burn any length of arc from $\frac{1}{32}$ to $\frac{1}{4}$ inch if desired.

The standard indicators used in the Easton system are an ampère meter and a voltmeter, which have a limited reading at the most sensitive part of the swing. They thus give very distinct readings for very small changes in the current or potential.

The switch board employed in this system possesses several novel features. In its simplest form, as designed for one dynamo and one circuit, Fig. 3, it consists of four binding posts, carrying spring contacts, and arranged at four equidistant points from a common centre. A disc having a free rotary movement of one quarter of a turn bears two conductive strips, which are adapted to make the desired connections among the binding posts, and also a projection adapted to operate an automatic switch which serves to place the field coils in or out of the circuit as required. If the machine is disconnected from the circuits the dynamo is on a short circuit, and the automatic switch will place the field coils out of the circuit. In this case the machine will generate no current, as there is no exciting force applied to the field magnets.

The first result of rotary movement of the disc is to connect the dynamo to the circuit, but not into it, as the dynamo and work circuits are still closed independently of each other. A further movement of the disc connects the dynamo into the work circuit, and the circuits are no longer closed independently of each other. A further movement of the disc, by means of the projecting part, operates the automatic switch lever and connects the field coils into the circuit, and, as the exciting force is now applied to the field magnets by means of the coils thereon, the dynamo now begins to generate a current through the circuit. If desired, other circuits may be connected in, with or after the first one, or in like manner other dynamos may be "coupled" on the same circuit or other circuits by providing for each the necessary switch. In the reverse action the field coils of course are automatically cut out of the circuit first, and afterward the circuit is disconnected from the dynamo and left closed past the dynamo circuit and totally removed from any connection thereto. If switches for other dynamos are included in the same work circuit, any of the dynamos may be switched into such circuit. Connections of improper polarity are thus impossible, as connections can only be made in one manner. The engraving, Fig. 4, shows an automatic switchboard arranged for a number of circuits.

The loop switch and door cut-outs, illustrated in Fig. 5, are based upon the same principle of action, but have no automatic switch, as it is not necessary.

Peckham's New Electric Motor Truck.

Our readers will remember that some weeks ago we described and illustrated in our columns a new form of motor truck designed by Mr. Peckham, and manufactured by the Peckham Street Car and Axle Company, of this city, and specially adapted for the work for electric street cars. Among the prominent and novel features of the truck described was the suspension of the motors from the top of the car frame instead of supporting them on crossway angle irons attached to the bottom of the truck, as in the earlier forms, the advantage of this new method of suspension being that the motors can adjust themselves to curves and grades without severe strain being put upon the gearing, and also the introduct on of a bridge truss to support the side frames. In the accompanying illustration is shown a further improvement introducing a modification of the first truck. In the first form the motion of the car frame might tend, if violent, to jar and injure the motor and gearing. To overcome this possibility, the separation of the motor and car frame has been effected in the following ingenious manner:

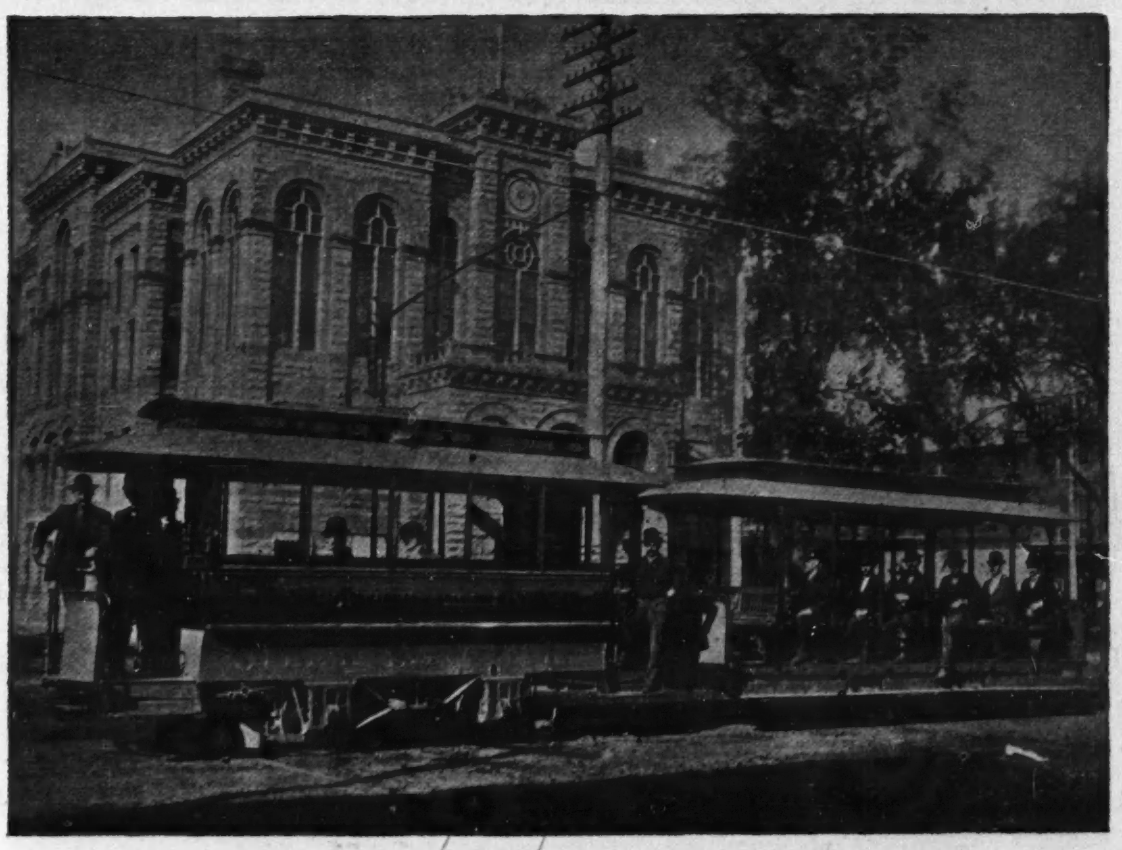
The bar which carries the snow plow and the motor support is directly suspended over the axle-box by means of a special form of pedestal, and the bridge truss is attached to this bar, and not connected in any way with the top of the truck, in such a manner that the motor is prevented from swinging with an up and down motion, in accordance with the movements of the car frame as it would do if rigidly joined to the frame of the truck. At the same time easy access is given to the motors and gearing, thus facilitating examination of the same and repairs when necessary. The car frame proper, as will be seen in the cut, is thus perfectly distinct from the motor supports and guard rail, giving an easy action to the car body, while the conditions are such that the motor adjusts itself to the direction of the wheels and axles while rounding curves, and prevents any undue strain on the working parts.

The Electrical Conductivity of Saline Solutions.

Numerous experiments on the electrical conductivity of saline solutions have been made by M. P. Chroustchoff. The methods were applied to mixtures of different salts in equivalent proportions. The conclusions arrived at are as follows: (1) Starting with any system of two salts, the same conductivity is obtained as with the inverse system; (2) the conductivity of the mixture is not the mean conductivity of either system of two salts, nor is it intermediate between the two mean conductivities, but is generally lower than either. This points to a reduction in the number of conducting molecules in the liquid, or, in other words, to the formation of double salts. The typical reaction as represented by the ordinary equation for double decomposition is rarely met with, and in almost all cases the change is complicated by secondary reactions. Other experiments were made with mixtures of two salts which were not likely to interact. The conductivity of each solution was determined separately, and they were then mixed in equivalent proportions. In some cases the observed conductivity of the mixture is the mean conductivity of its constituents; in another case it is lower. It follows that with the degree of dilution employed there is a reduction in the number of conducting molecules, either by formation of double salts, as with some of the sulphates, or by dissociation by the water, as in the case of zinc acetate. The *Journal* of the Chemical Society points out that it is noteworthy that, as a rule, mixtures of salts which crystallize with water have the mean conductivity of their on stituents, while the conductivity of mixtures of salts which form anhydrous crystals is below the mean.

The First Electric Road in the State of Illinois.

The first electric railway built in the State of Illinois is shown in the accompanying cut. It was constructed by the Thomson-Houston Electric Company, under their well known system, and has been in operation, at Ottawa, Ill., since Aug. 15, 1889. The length of the road, including the turnouts, is six miles of single track. The overhead construction has been used throughout. The cars are twelve in number, four equipped with two 15 h. p. motors each, and eight with two 10 h. p. motors each.



THOMSON-HOUSTON ELECTRIC RAILWAY AT OTTAWA, ILL.

The power plant for supplying the necessary current for the cars consists of a 200 h. p. engine, with necessary boilers, and two 80 h. p. generators, with complete station fittings. It has been frequently said by those who have witnessed the workings of this road, that if all the electric railways installed in the State subsequently work as well as this one has, the State will not want for efficient street car service.

Electric Lighting in Berlin.

It is now proposed to permit the Berliner Elecktricitaets-Werke to install its mains outside of the territory already granted to it. Even at the present time the company is not able to furnish current for all that demand it, and constant additions are being made. The amount of current which the stations are able to furnish may be estimated by the number of horse power of the stations. Thus the station at Nos. 43–44 Markgrafenstrasse is now operating with 3,480 h. p.; that at No. 80 Mauerstrasse, with 5,240 h. p.; and at No. 85 Friedrichstrasse, with 300. The new station at No. 49 Spandauerstrasse will be opened with 2,000 h. p., but is designed for an eventual capacity of 4,000 h. p. Finally, the station at the Schiffbauerdamm, now in course of construction, is designed for 10,000 h. p., and in order to meet the growing demand it is proposed to increase this to 15,000 h. p. Thus the total horse power devoted to electric incandescent lighting by this company will alone amount to 28,000.

The year ending June 30th showed 46,710 incandescent lamps connected to the circuit, which had aggregated a total of 25,907,360 lamp-hours; and to this must be added 144 arc lamps for street lights, which had burned in the aggregate 333,591 lamp-hours.

We have before us the annual report of the company, ending June, 1889, which shows their business to be in the most thriving condition. After making allowances of 5 per cent. to the reserve fund, for renewal account, depreciation, interests and donations to the officials and to the sick fund, a dividend of 8 per cent. was declared on a capital of 3,000,000 marks.

The Bundy Electric Cash Register.

Retail dealers in all kinds of wares are becoming more and more alive to the value of having a register of the amount of each purchase made by customers, not only as a check upon their employés but as a matter of convenience in keeping their accounts. A novel cash register of this description has recently been brought out by Mr. Willard L. Bundy, superintendent of the Bundy Manufacturing Company, of Binghamton, N. Y., which is illustrated in the accompanying engraving.

One of the principal advantages of this register is that it can be worked as readily with one hand as with two. As will be seen, the upper row of keys represents dollars, the next row dimes, and the lower row cents.

If the amount desired to be registered is, for instance, $7.91, one first presses on the key in the dollar row marked 7, then in the dimes' row on the key marked 9, and then in the row of cents on the key marked 1. The drawer of the register will not open until the key of the cents column is

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touched, when the drawer immediately opens and rings a bell.

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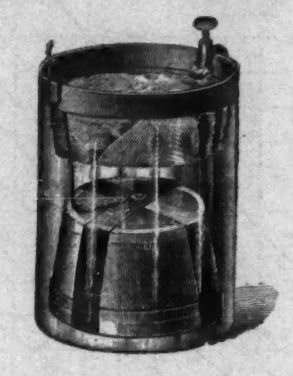

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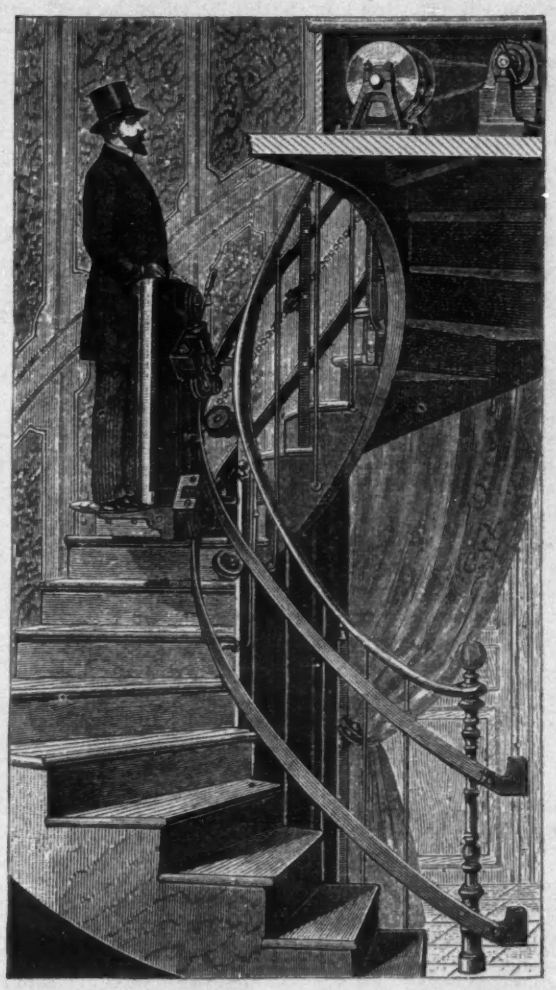

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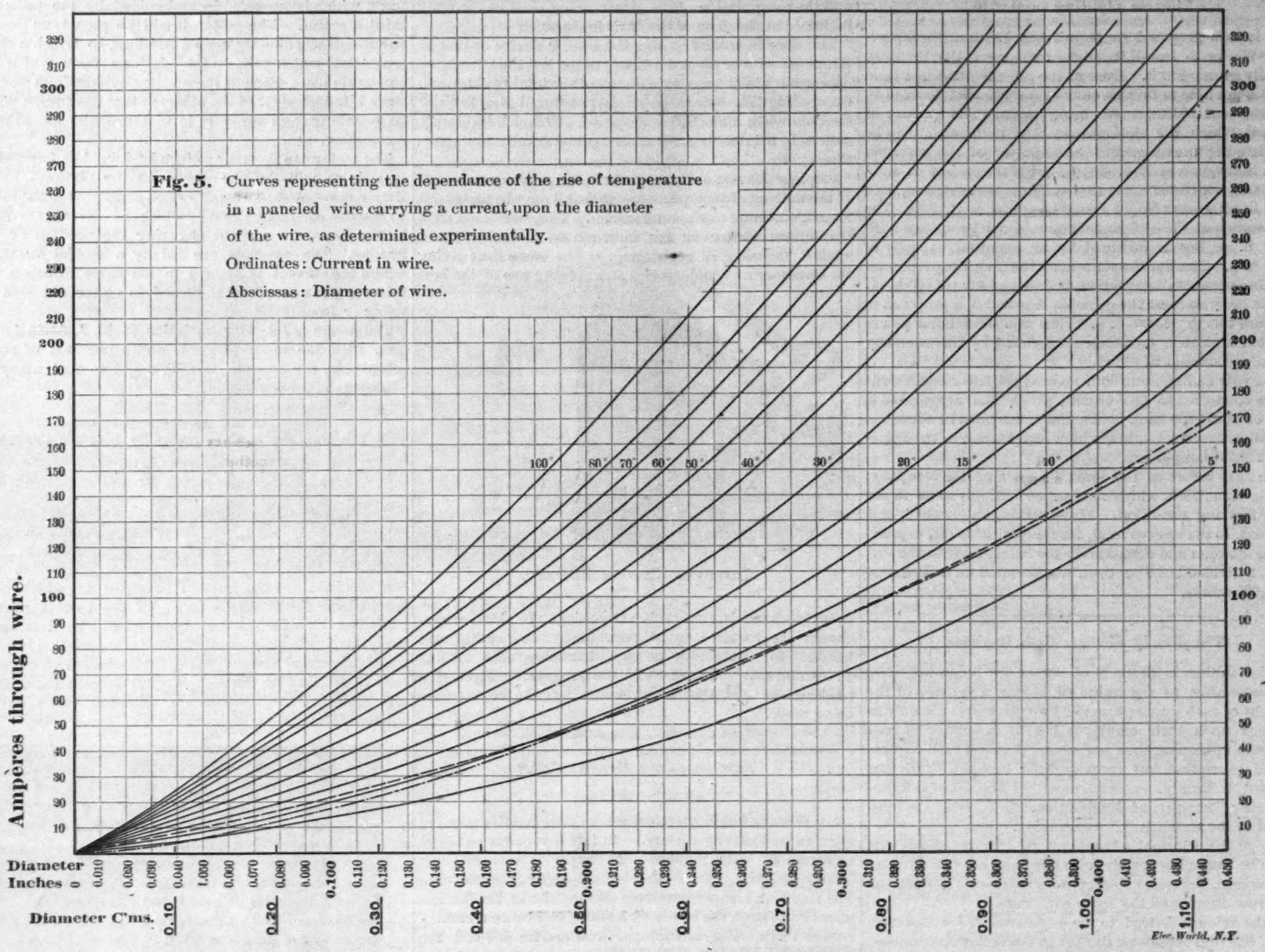
Fig. 5. Curves representing the dependance of the rise of temperature in a paneled wire carrying a current, upon the diameter of the wire, as determined experimentally.
Ordinates: Current in wire.
Abscissas: Diameter of wire.
Ampères through wire.
Diameter Inches
Diameter C'ms.
100° 80° 70° 60° 50° 40° 30° 20° 15° 10° 5°
Elec. World, N.Y.

FIG. 5.—CURVES REPRESENTING THE DEPENDENCE OF THE RISE OF TEMPERATURE IN WIRES, UPON THEIR DIAMETER.

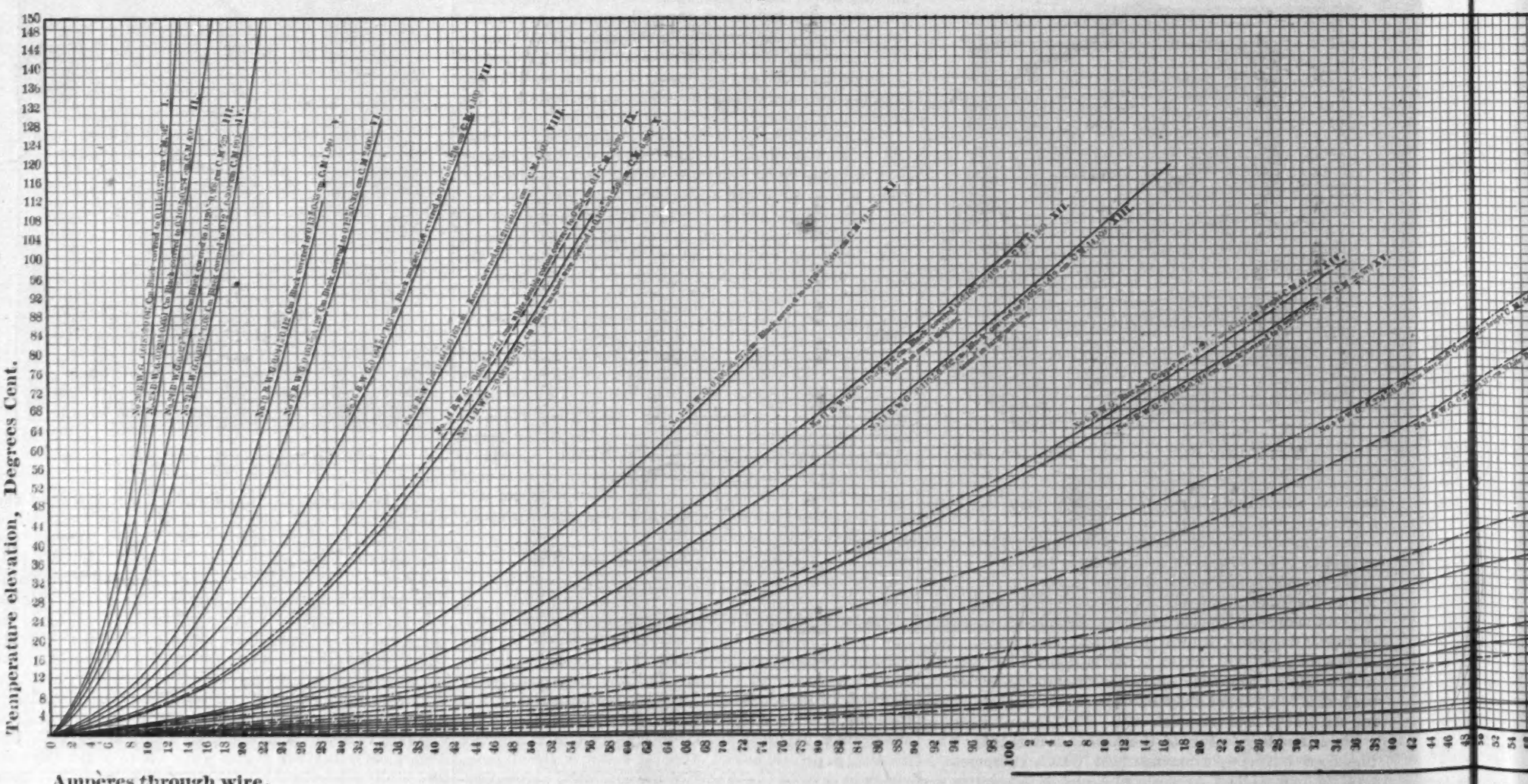

FIG. 4.—CURVES SHOWING THE RISE OF TEMPERATURE IN WIRES CA

little hope of a simple, yet rigorous, law applying. The loss of heat is taking place first by conduction through the insulating covering of the wire; then by conduction, convection and radiation through the enclosed air space; next by conduction through the woodwork, and finally into the floor or wall to which the panel is fixed, while radiation and convection carry off the heat from the free surface exposed to the air. Even under the simplest conditions that can be imposed in imagination upon the panel, such as cylindrical form with free access of air all round, and a tight fit upon the wire at the axis, the law of temperature increase with diameter for constant currents would involve the ratio of the panel diameter to the wire's diameter logarithmically, and the various dissymmetrical but practical conditions can only serve to make the law more complicated. In the absence then of any simple rigorous law, it becomes necessary to select some particular temperature elevation as the safe limit which a wire can be allowed to

reach under ordinary conditions, and then to find the best empirical rule which shall approximate as nearly as may be needed to the curve of experimental results.

The rule recommended by the Committee of the London Institution of Electrical Engineers for the prevention of fire risks in electric lighting, as published last year, was that: "The conductivity and sectional area of any conductor should be so proportioned to the work it has to do that if double the current proposed be sent through it the temperature of such conductor shall not exceed 150 degrees Fahrenheit." With this rule as a guide, the only remaining question is the normal temperature of the wires from which the rise is assumed to take place. A cellar in winter time might have a temperature of 40 degrees Fahrenheit (4.5 degrees Centigrade), while near the ceiling of an artificially-warmed room the thermometer might reach 100 degrees Fahrenheit (38 degrees Centigrade). As it would be out of the question to design every wire in a house for the exact temperature it might normally possess at different portions of its length, a fair mean temperature must be selected from which all elevations can be reckoned. This mean temperature may be taken at 75 degrees Fahrenheit (24 degrees Centigrade). This being admitted, the rule above mentioned requires that the temperature elevation of any wire shall not, with double the proposed current, exceed 75 degrees Fahr., *i. e.* reach above 150 deg. F. (41.7 deg. Cent.), and it has been seen that this is, for practical purposes, equivalent to the statement that the proposed current shall not produce an elevation of one-fourth that amount (10.4 degrees Centigrade).

Fig. 5 shows the general results arranged for the purpose of directly indicating the observed dependence of current strength and diameter for any given temperature elevation. Taking for granted that the 10 degrees Cent. elevation is that which prescribes the safely limit as above, then the empirical formula which shall best represent the 10-degree curve will form the rule by which the safe diameters of paneled wires may be determined. For the 10-degree C. curve itself it is difficult to find a simple equation, but for the broken line curve near it, — — —, which follows the current whose double raised the temperature 40 degrees C, the equation:

Limiting current in ampères = 560 (diameter of wire in inches)$^{\frac{3}{2}}$, is seen to be closely applicable except for very small wires, the curve — · — · —, in conjunction, being the strict locus of this equation.

This formula makes the small wires rather larger than experiment has shown they need be, but it will be seen that even then they are much smaller than the Board of Trade rule requires.

The following are then the proposed formulæ for determining the limiting safe currents and diameters for insulated copper wires in wooden panels:

$C = 500\ d^{\frac{3}{2}}$, if d be expressed in inches;
$= 0.01775\ d^{\frac{3}{2}}$, if d " " " mils;
$= 138\ d^{\frac{3}{2}}$, if d " " " centimetres;
$= 4.375\ d^{\frac{3}{2}}$, if d " " " millimetres.

And reciprocally,

$d = 0.0147\ C^{\frac{2}{3}}$, if d be expressed in inches;
$= 14.7\ C^{\frac{2}{3}}$, if d " " " mils;
$= 0.0374\ C^{\frac{2}{3}}$, if d " " " centimetres;
$= 0.374\ C^{\frac{2}{3}}$, if d " " " millimetres.

For ordinary purposes it is convenient to remember that when d is expressed in inches and C in ampères,

$$d = \frac{\sqrt[3]{C^2}}{70}.$$

From these data we have the following table giving in inches and centimetres the diameter of insulated copper wire necessary for any specified current:

Ampères	Minimum safe diameter of copper wire. Inches.	Cms.	Circular mils per ampère.	Fall of potential in wire at full load. Volts per foot.	Volts per metre.
1.....	0.015	0.038	225	0.0503	0.165
5.....	0.043	0.109	370	0.0305	0.100
10.....	0.069	0.175	480	0.0237	0.0777
15.....	0.090	0.229	540	0.0208	0.0681
20.....	0.109	0.277	590	0.0189	0.0621
25.....	0.126	0.320	640	0.0177	0.0581
30.....	0.142	0.361	670	0.0167	0.0548
35.....	0.158	0.401	710	0.0158	0.0518
40.....	0.172	0.437	740	0.0152	0.0499
45.....	0.186	0.472	770	0.0147	0.0481
50.....	0.200	0.508	800	0.0141	0.0461
55.....	0.213	0.541	825	0.0136	0.0447
60.....	0.225	0.572	845	0.0133	0.0437
65.....	0.238	0.605	870	0.0129	0.0423
70.....	0.250	0.635	890	0.0126	0.0413
75.....	0.262	0.655	915	0.0123	0.0403
80.....	0.274	0.696	940	0.0120	0.0393
85.....	0.285	0.724	960	0.0118	0.0386
90.....	0.296	0.752	970	0.0116	0.0379
95.....	0.307	0.780	990	0.0113	0.0372
100.....	0.318	0.808	1010	0.0111	0.0365
110.....	0.339	0.861	1040	0.0108	0.0353
120.....	0.358	0.909	1070	0.0105	0.0346
130.....	0.377	0.958	1090	0.0103	0.0337
140.....	0.396	1.01	1120	0.0099	0.0327
150.....	0.415	1.05	1150	0.00975	0.0320
175.....	0.461	1.17	1210	0.00929	0.0305
200.....	0.504	1.28	1270	0.00887	0.0291
225.....	0.545	1.38	1320	0.00853	0.0280
250.....	0.585	1.49	1370	0.00817	0.0268
275.....	0.623	1.58	1410	0.00798	0.0262
300.....	0.660	1.68	1450	0.00771	0.0253
325.....	0.697	1.77	1490	0.00753	0.0247
350.....	0.732	1.86	1530	0.00734	0.0241
375.....	0.766	1.95	1570	0.00716	0.0235
400.....	0.800	2.03	1600	0.00714	0.0234
425.....	0.832	2.11	1630	0.00692	0.0227
450.....	0.865	2.20	1660	0.00674	0.0221
475.....	0.897	2.28	1690	0.00665	0.0218
500.....	0.928	2.36	1720	0.00652	0.0214
550.....	0.988	2.51	1775	0.00634	0.0208
600.....	1.049	2.66	1840	0.00616	0.0202
700.....	1.16	2.95	1920	0.00585	0.0192
800.....	1.27	3.23	2070	0.00558	0.0183
900.....	1.37	3.48	2080	0.00539	0.0177
1000.....	1.47	3.73	2160	0.00521	0.0171

DATA: Insulated house wires carrying continuous currents, and encased in wooden paneling. Copper resistivity: 1.650 microhms @ 0° C. = 1.870 microhms @ 34° C. assumed temperature of full load. Conductivity allowed 98 per cent.

This table shows that whatever temperature elevation might be adopted as the safety limit, the principle of fixing upon the diameters of conductors by allowing a certain number of ampères to the square inch, or a certain number of circular mils to the ampère, can only be very imperfect unless a sliding scale be arranged. Thus the diameter of wire which coincides with the Board of Trade limit of 1,000 ampères per square inch is 0.504 inch for 200 ampères. According to the table that rule would not be safe for wires above that diameter, while for wires beneath that diameter it would, in respect to safety, be very uneconomical. Thus to carry 400 ampères at 1,000 ampères per square inch requires 508,000 circular mils; or a diameter of 0.713 inch, while the table indicates 0.800 inch, and on the other hand to carry 40 ampères the same rule calls for 0.225 inch, the table showing only 0.172 inch to be necessary.

For the same reason, when the space occupied by the wires is no object there is always an economical limit to the size of the main in any house installation, for if the fall of potential permissible in them reduces their selection to pure considerations of safety, then it will always be more economical to subdivide the conductors for heavy currents. For example, if 500 ampères have to be carried at full load, the table indicates a main of 0.928 inches (2.36 centimetres) in diameter. But by taking two equal mains each carrying 250 ampères, their diameters will be 0.585 inches (1.49 centimetres) and the weight of copper will be reduced rather more than 20 per cent., and in all cases whenever 20 per cent. of the cost of copper necessary for one main will more than cover the expense of another insulating covering and paneling for the second wire, there being no independent objections, it will be economical to divide the conductor.

This remark is of course not merely a deduction from the table, nor in any way implicated with the limiting temperatures on which it is based, but is founded on the fact that when a wire's diameter is doubled, although it takes twice as strong a current to develop the same heat as before per unit volume, there will be four times as much total heat and only twice as much surface through which that heat has to find egress.

Referring to the general curve sheet, certain deductions may be made from it concerning the effect of the nature and thickness of insulating covering, and also the influence of the panel dimensions.

The evidence is distinct that with all the wires tested, and which had the usual thickness of insulating covering [about 0.050 inch (0.13 centimetre) for the small and large wires, with about 0.035 inch (0.09 centimetre) for the intermediate sizes], the effect of the insulation covering was to cool the wire. Thus curves Nos. XIV., XVI. and XVIII., Fig. 4, represent the observations on bare copper wires, and show that their temperature elevations were fully 30 per cent. in excess of that found in covered wires of equal diameter and load. Again, curve No. VIII. refers to a kerite wire whose coating was 0.073 (0.185 cm.) inch thick. Its temperature elevation is seen to have been about 30 per cent.

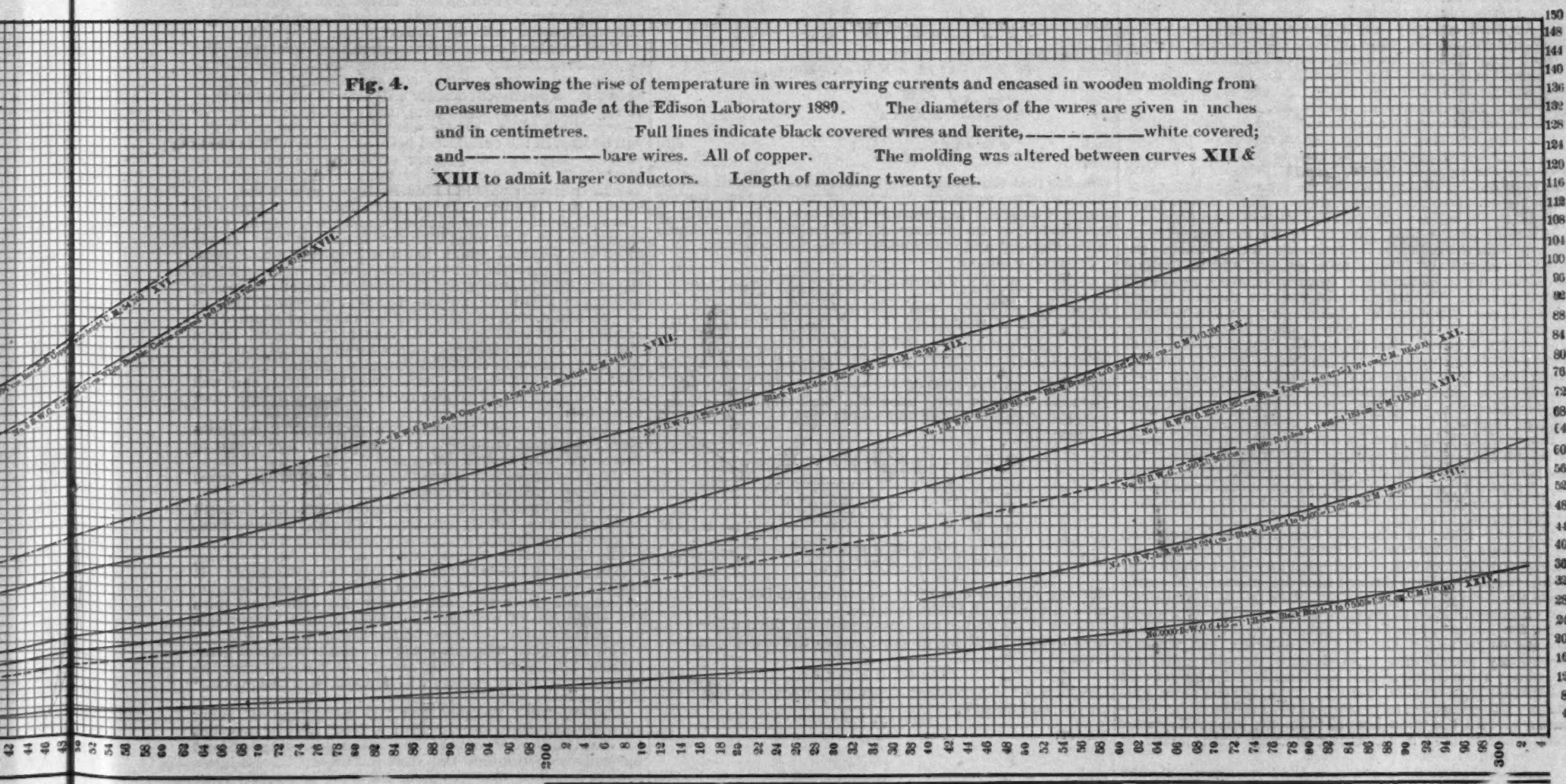

Fig. 4. Curves showing the rise of temperature in wires carrying currents and encased in wooden molding from measurements made at the Edison Laboratory 1889. The diameters of the wires are given in inches and in centimetres. Full lines indicate black covered wires and kerite, ———— white covered; and — — — — bare wires. All of copper. The molding was altered between curves **XII** & **XIII** to admit larger conductors. Length of molding twenty feet.

Electrical World, New York.

E IN WIRES CARRYING CURRENTS AND ENCASED IN WOODEN MOLDING.

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equal. No. IX. was double covered with white cotton; No. X. single covered with blackened cotton. All the ordinary insulated house wires were covered at the Edison Machine Works, Schenectady, N. Y., with cotton soaked in a special insulating liquid. The temperature elevation of the latter was about 4 per cent. the lower, and while it is possible that this differencc may have been due to the superior radiating power of the black coating, it is not sufficiently marked to be more than a possibility.

Curves Nos. XII. and XIII. show the temperature elevations of the same length of wire first in the smaller paneling and then in the larger. In the latter case there is a cooling effect visible, amounting to 10 per cent.

The conclusion rests, that while the exact temperature elevations of a paneled wire depends upon a variety of factors, it is capable of being fairly estimated from the average of a number of experiments under actual conditions, and care has been taken to obtain these measurements under as nearly practical conditions as possible. The mean conductivity of the wires was about 99 per cent.; that is to say, a mean resistivity of 1,640 absolute legal units. The temperature coefficient has been taken at $1 + 0.00388\,t$, t being the elevation in degrees Centigrade.

In applying the rule for safety limitation as given by the table, insulated wires are, of course, to be understood, and no particular thickness or quality of insulation need then be specified. For although extra thick insulating covering cools the wire, it would not be desirable to render it specially thick merely with that object in view. Also each wire should have its own groove, or, if several wires are in the same channel, the total area and surface of the woodwork should be correspondingly large. Finally, the paneling should be run as far as possible through places not exposed to an abnormally high temperature.

Form and Efficiency of Incandescent Filaments.*

BY CHARLES J. REED.

If we pass an electric current through any conductor, as a cylindrical wire. its temperature tends to increase by the transformation of electrical energy into heat. If no heat is allowed to escape, the temperature will increase indefinitely, or until the conductor is melted or otherwise destroyed. If the heat is allowed to escape by radiation alone from the surface of the conductor, its temperature will increase only until the rate of loss by radiation is exactly equal to the rate of tranformation. By heat we here include all radiant energy, whether of high or low degree.

As the temperature of an incandescent body increases, not only does the actual quantity of radiant energy increase, but its wave-lengths diminish. Hence, as experience has shown, after incandescence is reached, increasing the temperature in a given ratio increases the light emitted in a much greater ratio.

The exact relation between temperature and luminosity is not known, and it is probably not very simple, if such a relation exists at all. The phenomenon of luminosity is really a physiological one and depends partly upon individual optical capacity; some persons being able to see above and some below the visible spectrum of the average human eye. The radiant energy we call light is one thing; the sensation of luminosity by which we always estimate light is an entirely different thing. A constant source of light may vary greatly in luminosity, according to the condition of the receptive mechanism and its individuality.

But even ignoring the physiological aspect of the question, the nearest approach we have to formulæ for radiation are the approximate empirical formulæ of Dulong and Petit and of Stefan; which are for total radiations of a low temperature and limited range. They cannot apply to light alone, nor even to total radiation of high degree.

It is unfortunate that there exists no instrument more reliable than the retina of the living eye for measuring the intensity of radiant luminiferous energy, and no method of reading the measurements more accurately than individual guesses. We can measure radiant thermal energy of low degree with Langley's bolometer; we can measure radiant actinic energy by the chemical action it produces; and we can measure total radiant energy in a variety of ways; but how can we isolate or measure radiant luminiferous energy? If there were a high temperature thermometer or other instrument for accurately measuring high temperature, we might attack this problem with some hope of results.

It is sufficient, however, for our present purpose to know what the eye is able to tell us, namely, that increasing the temperature increases the light in a greater ratio. From this it follows that the efficiency of an incandescent filament is some direct function of its temperature above that of the surrounding space.

Granting that the efficiency increases with increased temperature, we have now to determine whether the efficiency does, or does not, depend upon any other conditions. It has frequently been claimed that the efficiency depends upon the form of the filament, whether it be cylindrical, flat or square. At a meeting of this Institute, of June 8, 1886, for instance, this was by general consent considered an established fact.† Others have asserted, but without giving any proof, that the efficiency depends upon the pressure; some claiming that low-tension series lamps, and others that high-tension multiple lamps, are the more efficient. Others, again, have claimed that at the same pressure and with the same shaped filament, lamps of greater candle power have a different efficiency from lamps of smaller power.

The trouble seems to have been that we are not always careful to distinguish between efficiency and convenience or adaptability. Each individual finds that a certain form of filament or a certain method of distribution giver better satisfaction than another or is more suited to his purpose, and soon persuades himself that it is "more efficient" than any other.

In order to study the effects of these various conditions upon the efficiency of a filament, it will be convenient to eliminate the effects which we know will be produced by variations in temperature. We assume, therefore, in this discussion that all the filaments, and all parts of the filaments, under consideration are at the same temperature.

Let T represent this temperature and T' the temperature of the supposed vacuous space surrounding the filament. We must assume further that the material of which the filaments are constructed is perfectly homogeneous in itself and that it is uniform in all the various forms of filaments considered.

Let S denote the specific radiating power of the material at the temperature, T and S' its specific resistance at the same temperature.

Any variation in S or S' might affect the efficiency, and for this very reason experimental proof is very difficult to obtain. Comparisons of filaments made by different processes are entirely worthless in determining the effect of form or length of a filament on its efficiency.

It is a difficult matter to produce by the same process two carbons of different sizes and shapes that shall have the same specific radiating power and specific resistance at the same temperature. And to produce them by different processes is entirely out of the question. Any comparison, therefore, of short, series filaments with long, multiple filaments of a different manufacture is of no value whatever in settling this question.

Let C represent the candle-power of any filament at temperature, T.
c represent its current.
E " the potential difference at its terminals.
R " its resistance.
r " its radius (considered as a cylinder).
L " its length.
H " the energy received per unit of time.
H' " the energy radiated per unit of time.

Since the energy developed in any portion of an electric circuit is proportional to the current and pressure, we have

$$H = K E c, \tag{1}$$

in which K is a constant depending upon the units employed.

If we neglect the small quantity of heat lost by conduction from the ends of the filament to the conducting wires, and assume that the space surrounding the filament is a perfect vacuum, then the entire energy of the current will be expended in radiation, and we have

$$H = H'. \tag{2}$$

Let K' represent a constant depending on $(T - \varepsilon')$.

The rate of radiation of any surface depends only upon the elevation of its temperature above that of the surrounding space and the specific radiating power of the surface at that temperature. We have, therefore,—

$$H = H' = K' S \times 2\pi r L = K E c. \tag{3}$$

The resistance of any conductor is proportional to its length and inversely proportional to its cross-section, and we have—

$$R = S' \frac{L}{\pi r^2}. \tag{4}$$

From Ohm's law and (4)

$$c = \frac{E}{R} = \frac{E \pi r^2}{S' L} \tag{5}$$

By eliminating successively E, c and r from (3) and (5) we get

$$\frac{K' S \times 2\pi r L}{K c} = \frac{c S' L}{\pi r^2}, \text{ or } \frac{c^3}{r^3} = \frac{2\pi^2 K' S}{K S'} \tag{6}$$

$$\frac{K' S \times 2\pi r L}{K E} = \frac{E \pi r^2}{S' L}, \text{ or } E^2 r = \frac{2 K' S L^2 S'}{K} \tag{7}$$

and

$$\frac{K E c}{K' S \times 2\pi L} = \sqrt{\frac{c S' L}{\pi E}} \tag{8}$$

From (6)

$$K' S \times 2\pi^2 r^3 = K S' c^2. \text{ Hence,}$$

$$r = \sqrt[3]{\frac{K S' c^2}{2 K' S \pi^2}} \tag{9}$$

and

$$c = \pi \sqrt{\frac{2 K' S r^3}{K S'}}; \tag{10}$$

showing that the square of the current is proportional to the cube of the radius or diameter of the filament for all lamps at constant temperature; and that this relation is independent of the pressure, of the length and resistance of the filament and independent of the candle power.

From (7) we have

$$K' S \times 2 L^2 S' = K E^2 r. \text{ Hence,}$$

$$L = \sqrt{\frac{K E^2 r}{2 K' S S'}} = E \sqrt{r} \sqrt{\frac{K}{2 K' S S'}} \tag{11}$$

and

$$r = \frac{L^2}{E^2} \times \frac{2 K' S S'}{K}; \tag{12}$$

showing that the ratio of the square of the length to the diameter depends only upon the pressure, and is independent of candle power and resistance.

From (8)

$$K^2 E^2 c = 4\pi K'^2 S^2 S' L^2. \text{ Hence,}$$

$$E = \frac{L}{\sqrt{c}} \sqrt[3]{\frac{\pi K'^2 S^2 S'}{K^2}} \tag{13}$$

and

$$c = \left(\frac{L}{E}\right)^2 \times \frac{4\pi K'^2 S^2 S'}{K^2} \tag{14}$$

showing that the current is proportional to the cube of the ratio of the length to the pressure.

Since K', S and S' are constant, both the light and the heat radiated will be proportional to the surface, and we have

$$C = K'' L \times 2\pi r \tag{15}$$

in which K'' is a constant depending upon the units employed, and upon T.

Hence,

$$L = \frac{C}{2\pi K'' r} \tag{16}$$

and

$$r = \frac{C}{2\pi K'' L}. \tag{17}$$

Combining (15) with (3)

$$\frac{K' S C}{K''} = K E c, \text{ or}$$

$$\frac{C}{K E c} = \frac{K''}{K' S}, \tag{18}$$

which shows that the candle power is proportional to the energy, $K E c$; or that the efficiency, $\frac{C}{K E c}$, is constant and independent of the pressure, length, radius, resistance, current and candle power of the filament. This means that the energy required to produce a given candle power will be proportional to the candle power and will be the same, whether it is expended in driving a large current through a short, thick filament, or a small current through a long, slender filament; provided the temperature or state of incandescence is the same and provided no heat is lost by conduction through the terminal wires.

Equation (18) shows also that the efficiency does depend upon K', K'' and S; that is, upon the temperature of the filament, the temperature of the surrounding space and the specific radiating power, and upon them only.

From (18)

$$C = Ec \times \frac{K K''}{K' S}; \tag{19}$$

$$E = \frac{C}{c} \times \frac{K' S}{K K''}; \tag{20}$$

and

$$c = \frac{C}{E} \times \frac{K' S}{K K''} \tag{21}$$

From (4)

$$r = \sqrt{\frac{S' L}{\pi R}} = \sqrt{\frac{S'}{\pi}} \times \sqrt{\frac{L}{R}} \tag{22}$$

and

$$L = \frac{\pi r^2 R}{S'} \tag{23}$$

From (5)

$$E = Rc \tag{24}$$

From (21) and (24)

$$c = \frac{C}{c R} \times \frac{K' S}{K'' K} = \sqrt{\frac{C}{R}} \times \sqrt{\frac{K' S}{K'' K}} \tag{25}$$

We have thus far confined ourselves to the consideration of cylindrical filaments varying in length and diameter. It remains now to show that the efficiency is independent of the form of cross-section.

Let us suppose we have a number of lamps, all made of the same material, having the same specific resistance and radiating power, all burning at the same temperature and all giving the same amount of light. Let them be of any pressure and let the cross-section be of any form, circular, elliptical, square, triangular, etc. The filaments will all have equal radiating surfaces; since unequal surfaces of the same character at the same temperature could not radiate equal amounts of light. But equal surfaces of the same character at the same temperature must radiate equal amounts of heat of all wave lengths. Hence, the total amounts of radiant energy are equal. Since the energy received is equal to the energy radiated and the amounts of light are equal, we have

$$C = Q E c, \tag{26}$$

in which Q is a constant, and from (18) we find its value to be

$$Q = \frac{K K''}{K' S}. \tag{27}$$

This shows that the efficiency is independent of the form of cross-section of the filament and depends only upon its temperature, the specific radiating power of its surface and the temperature of the surrounding space.

When we find, therefore, that one lamp is more efficient than another, we must infer, not that it is on account of larger or smaller size, not because it is on a series or on a multiple circuit, not that it is because it has high or low resistance, or a certain form of cross-section, but that it is at a higher temperature, or is made of material having a different specific radiating power.

Of all possible forms of cross-section the circular has the largest area for the same radiating surface per unit of length, and, consequently, has the advantage of great strength. The current density will also be less in this than in any other form; and hence, any "disintegrating" or "electrolytic effect" of the current, if there is any such, will be least in the cylindrical filament. This will be made clear by supposing a number of lamps of equal candle power to be burning at the same temperature and pressure, but having various forms of filament, cylindrical, flat, square, etc. We have already seen that these lamps all consume equal amounts of energy, and since they have the same pressure, they must take the same current. Therefore, the filament which has the greatest area of cross-section will have the least current density. The fact that the cylindrical filament has the greatest cross-section does not signify that it will require a greater current to keep it at the same temperature. Its form is better adapted for retaining heat than any other. Again, the several lamps will have equal resistances; otherwise they could not take equal currents with the same pressure. From this it follows that the cylindrical filament will be longer, and will have less surface and greater mass per unit of length than any other.

A tubular filament would have a greater external diameter, but smaller cross-section of material, and would be shorter than the cylindrical.

The advantages and disadvantages of the various forms may be summed up as follows:

The cylindrical has the advantage of greater strength and less current density on account of greater cross-section. It has the disadvantage of greater length and fragility.

The tubular filament is strongest in form, being shorter and of greater external diameter than the cylindrical. It has the disadvantage of greater current density than the cylindrical. Both the tubular and the cylindrical have the advantage of uniform illumination in all directions except in and near the plane of the filament.

Flat or angular filaments have the disadvantage of great current density and of being unequally heated, since the edges or projecting corners will always be a little cooler* than the other parts.

A short, thick filament has the advantage of being stronger and more durable than a long, slender one; but the disadvantage of wasting a greater percentage of heat by conduction through the terminal wires. In this latter respect it is true that the long filament is slightly more efficient than the short. A 10-ampère filament a foot long would waste no more energy by conduction than a 10-ampère filament an inch long.

Aside from the difficulty of obtaining lamps of different

* Read before the American Institute of Electrical Engineers, New York, Nov. 19, 1889.

† Transactions Am. Inst. E. E., Vol. IV., p. 20-23.

* It was asserted before this Institute, June 8, 1886, that the edges or corners of a square filament are hotter than the remainder of the surface; but no reason was given. Such a statement scarcely needs refutation, being contrary not only to established laws but to the most commonplace and everyday experience. We need only observe the cooling of a square bar of red-hot iron to convince ourselves that the sharp corners are the coolest parts. And they would remain the coolest parts even if heat were continually supplied by an electric current to the interior of the bar.

types from different makers which have the same specific resistance and radiating power, there is the difficulty, or rather impossibility, of getting them all to burn at the same temperature, and the difficulty of knowing, even approximately, what that temperature is, and whether it is the same in two lamps or not. For these reasons no experimental comparisons yet published are of any value, either in corroborating or refuting these conclusions. There is one method, however, of testing the formulæ. This method the writer has tried upon some twenty-five different types with the most satisfactory results. The method is as follows:

A lamp is constructed with a filament of known dimensions, treated to the required process and exhausted to a certain pressure, as determined by a McLeod vacuum gauge. It is then placed on a circuit of a certain pressure, which gives it a certain desired temperature or efficiency, and the candle power and current are measured. From the data thus obtained we calculate by the above equations all the data for lamps of other types. The lamps, when made according to this data from the same material by the same process, and exhausted to the same pressure, should give the calculated candle power at the calculated pressure.

It must be remembered that the formulæ take no account of the small amount of heat that escapes by conduction through the wires. With lamps of high resistance this may safely be ignored in practice, but in changing from a long to a very short and thick filament it must be taken into account.

The following examples may serve to better illustrate the method:

Let us suppose a lamp has been constructed to give a certain candle power on a circuit of given pressure, and it is desired to construct other lamps having the same efficiency (temperature) and life, but of different candle power, for the same, or for different, pressure. We will call this lamp for convenience the zero lamp, and denote its particular values of the variables by the subscript, °.

Let $C = C_\circ = 16$ candles.
$c = c_\circ = .6$ ampère.
$E = E_\circ = 100$ volts.
$R = R_\circ = 167$ ohms.
$L = L_\circ = 170$ millimetres.
$r = r_\circ = .07$ millimetre.

The constants K, K', K'', S and S' will have the same value for all values of C, c, E, R, L and r, and hence will be found by substituting for these quantities the simultaneous values, $C_\circ$, $c_\circ$, $E_\circ$, $R_\circ$, $L_\circ$ and $r_\circ$, respectively.

If H is measured in horse power, we have from (1), $K = \frac{1}{746}$. From (4)

$$R_\circ = S' \frac{L_\circ}{\pi r_\circ^2}, \text{ or}$$

$$S' = \frac{\pi R_\circ r_\circ^2}{L_\circ} = \frac{\pi \times 167 \times (.07)^2}{170} = .015122;$$

from (3)

$$K' S = \frac{K E_\circ c_\circ}{2 \pi r_\circ L_\circ} = \frac{100 \times .6}{746 \times 2 \pi (.07) \times 170} = .0010757;$$

from (15)

$$K'' = \frac{C_\circ}{2 \pi r_\circ L_\circ} = \frac{16}{2 \pi (.07) \times 170} = .21399.$$

Substituting these values of K, K'', S and $K' S$ in equations (4) to (25), we are enabled to solve any problem involving R, E, C, r, c, and L, when any two of the quantities except c and r are given. The equations apply only to lamps of the same material and at the same temperature as the zero lamp. By starting with a lamp of different material, or by burning the same lamp at a different temperature, we obtain a different set of constants, which, substituted in equations (4) to (25), adapt them to the changed conditions.

Suppose we wish to construct a lamp of 20 candle power for a 90-volt circuit:—

$C = 20.$
$E = 90.$

From (21)

$$c = 3.75 \frac{20}{90} = .8333 \text{ ampère};$$

from (9)

$$r = .098466 \sqrt[3]{(.8333)^2} = .087196 \text{ millimetre};$$

from (11)

$$L = 6.4190 \times 90 \sqrt{.087196} = 170.59 \text{ millimetres}$$

and from (4)

$$R = .0048134 \frac{170.59}{(.087196)^2} = 108.00 \text{ ohms.}$$

The calculations may be verified by substitution in some of the other formulæ.

In constructing the lamp we take a filament 170.59 millimetres long, and of such a radius that, when treated to the given process until at the proper exhaustion it takes .833 ampère with 90 volts, it will have a radius of .0872 millimetres. If the treatment of the carbon does not increase its diameter, the initial and final radius will be the same; but the radius of the *finished carbon* is to be .0872 millimetre. When these conditions are fulfilled, we know with certainty that the lamp has the proper temperature if it gives 20 candles. If any single condition is not fulfilled, we know with the same certainty that the lamp has not the proper temperature. If two or more of the required conditions are simultaneously not fulfilled, then we know nothing about the resulting temperature.

We are thus enabled to construct lamps of uniform life for varying conditions of current and candle power; and also to regulate the length of life and the efficiency, increasing or diminishing either the life or the efficiency at pleasure to suit the requirements of particular conditions, remembering always that the life and efficiency are inverse functions of each other.

The fact that the life of most commercial lamps is very irregular shows that either the material or the temperature is not uniform, and hence, that there is lack of uniformity either in the process or in the dimensions. The writer has examined a number of different makes of lamps, and found that they generally vary in length and cross-section enough to produce serious differences in temperature.

Suppose, again, we wish to construct a 50-candle lamp for a series circuit of 5 ampères:

$C = 50.$
$c = 5.$

From (20)

$$E = 3.75 \times \frac{50}{5} = 37.5 \text{ volts};$$

from (9)

$$r = .098466 \sqrt[3]{(5)^2} = .28792 \text{ millimetre};$$

from (11)

$$L = 6.419 \times 37.5 \sqrt{.28792} = 129.16 \text{ millimetres};$$

from (4)

$$R = .0048134 \frac{129.16}{(.28792)^2} = 7.5 \text{ ohms.}$$

In this case the loss of heat by conduction through the connecting wires is considerable, and must be taken into account.

The above equations are not limited to incandescent filaments, but apply equally to any conductor which may be kept at a certain fixed temperature by an electric current. By using the proper constants, useful formulæ may be derived for calculating conductors, so that under given conditions they will be heated to a required temperature.

A Line-Adjusting System.*

BY P. B. DELANY.

I take pleasure in bringing before you this evening an improvement in telegraphy, which, although of recent date, has already been proven to be practical and beneficial in its operation. I have called it a "Line-Adjusting System." This title is not strictly correct, but it is the most comprehensive one I could think of. The system keeps relays at intermediate stations in a telegraphic circuit in adjustment in bad weather.

In this country we call a partial loss of current to the earth "escape," to distinguish that condition from a "ground," which means total loss. The terms "light escape," "heavy escape" and "ground" express the different degrees of depletion of a telegraph wire of its current; demoralization in the operation of telegraphs is proportioned, relatively, to each degree. No one who is not, or has not been, a telegrapher can appreciate the trouble and turmoil which a rainy day brings to a telegraph wire, especially to a way-wire, such, for instance, as the dispatching wire of a railway on which there are usually a large number of intermediate offices. Light escape means trouble; but heavy escape means chaos. Improvement in insulation has done much toward remedying the difficulty, but perfect insulation cannot be obtained nor would it be altogether desirable; for then the wires could not in all cases be worked at as high a speed as with the present faulty insulation. What is needed is an insulation constant in its imperfection. So long as bare wires are strung on poles, and rain and sunshine succeed each other, there will be a fluctuating condition of insulation, and consequently an ever changing current on the line, and, as a matter of course, corresponding changes in the attraction of the relay magnet for its armature. These changes in the magnetic pull necessitate readjustments of the retractile spring, the tension of which must always be regulated so as to allow the armature to move quickly between its limits, in response to the make and break of the circuit at the operator's key at any station on the line.

It does not follow, however, that a loss of current through bad insulation means a weakening of the electro-magnetism in all the relays. This is generally the effect near the middle of the line, provided the escape is about equal on either side, but at stations near the ends of the line, where the main batteries are located, a heavy escape means a reduction of resistance of the circuit by the partial ground established beyond them, so that they get the force of the main battery from the terminal near them over a comparatively short circuit. Under such conditions the stations near the ends of the line can work with the rear terminal, and stations between with a very low tension on the retractile spring, while it would be impossible for them to receive signals from the distant terminal, or offices beyond the middle of the line, on the same adjustment. A much higher tension must be put on the spring. On a line having an evenly distributed escape throughout, offices near the middle should not have as much difficulty in adjusting as offices near the ends, provided, of course, that the escape is not so heavy as to leave them insufficient current to work with.

It frequently happens, however, that a storm extends only over half the line. Under this condition all the offices on the clear end of the line work with each other on a low adjustment, but require a high adjustment to hear the offices on the storm-bound end of the wire. Operators naturally prefer a low adjustment to a high one. When they are sending, their relay armatures and sounder levers respond promptly to the manipulation of the keys, making the work much easier. With a high adjustment the drag of the sounder click behind the movement of the key renders manipulation laborious. Hence it is that an operator who has at one minute been receiving from a distant station, requiring high adjustment, will, when he

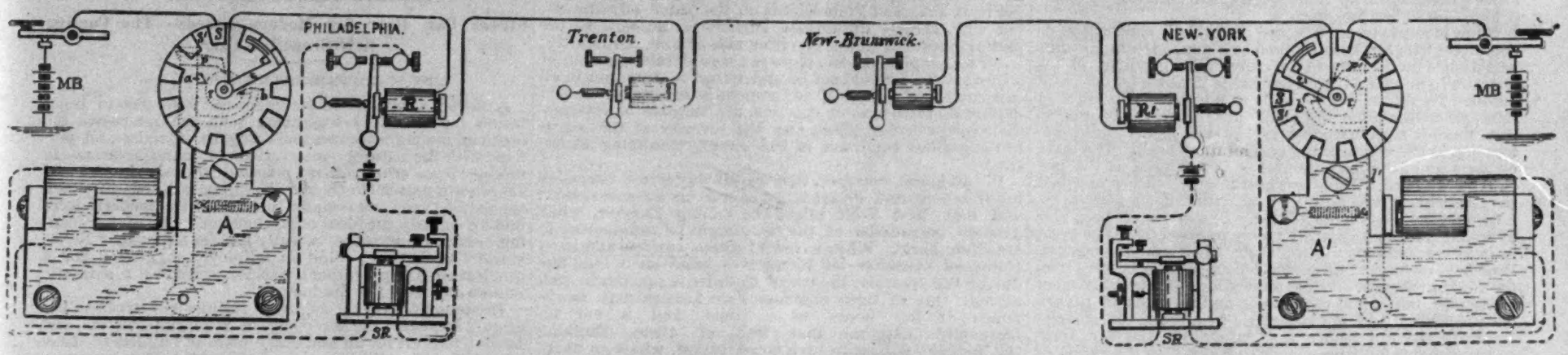
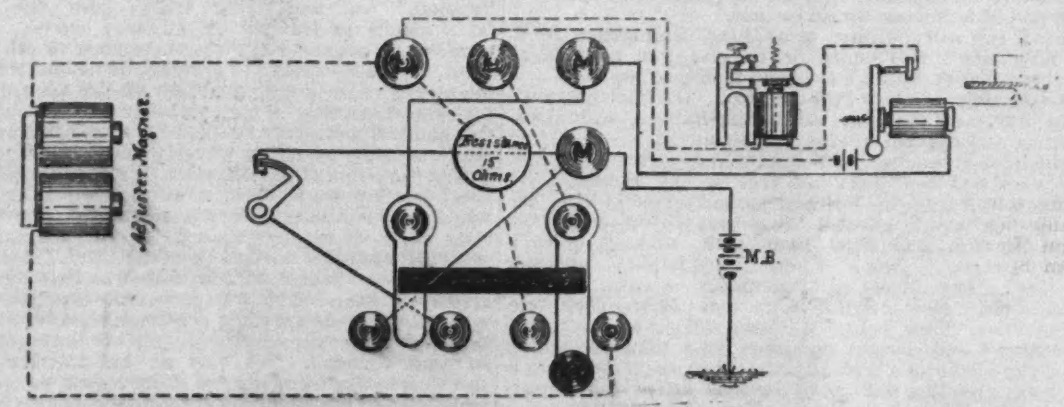
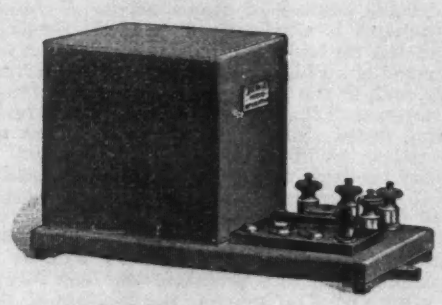


FIG. 1.—THE DELANY LINE ADJUSTING SYSTEM.





FIGS. 2 AND 3.—THE DELANY LINE ADJUSTING SYSTEM.

* A paper read before the American Institute of Electrical Engineers, New York, Nov. 19, 1889.

comes to send a return message, turn down his adjustment, so that his sounder will follow his key smoothly. Then if the distant station finds it necessary to stop him, he does not feel the break, but goes right on sending.

I have noticed that nearly all operators, good and bad, are vain of their abilities to send rapidly, and nearly all are ambitious to send faster than the operator at the receiving station can write it down, or in other words to "rush" him. This is especially true of young operators, but, taking them collectively, I do not think there is a body of craftsmen in existence who work so willingly as telegraphers. Each seems individually impelled to "salt" the man at the other end of the line, if possible, and when he succeeds in making him "break," he mentally records a victory, and goes at it again with renewed vigor. To outsiders this self-imposed rapid pace may seem foolish, but to the knight of the key there is a great glory in it. That great artist never lived, actor, orator, or musician, whose soul was more thrilled at the plaudits of thousands than is the soul of the expert telegrapher when, with faultless and rapid transmission, he humbles a great receiver by compelling him to beg for quarter.

There is music in it, too, and the pride is pardonable, as every one who has been chained to a mad stream of dots and dashes by the hour in the stilly night, bending all his energies to keep the thread and write it down legibly, will admit. Therefore it is not to be wondered at that on way lines, where ambition and ability are greatly out of proportion, there is always trouble in bad weather. The operators are, in the main, young and inexperienced. The lines, on account of the large number of instruments in the circuits, work hard. There is "breaking in," delay and bad temper. This is especially the case with railway telegraphs, where perfection is most needed. I have never been able to understand the niggardly policy pursued by many great railway corporations toward their telegraph department. Poor pay, overwork, miserable accommodations, have been the rule in the past. While money has been lavishly spent in sleepers, buffet and parlor cars, and all kinds of luxurious upholstery and conveniences to attract the traveler by rail, the rail itself, the safety of the car, train and passengers have been made to depend on the ability of some overworked boy at some far off way station to resist sleep at a time when he ought to be snugly tucked away in bed. If the traveling public would look more discriminately at the electrical equipment of railroads, and take less account of tapestry and tinsel, they would in many thousands of cases, I am sure, change their line. It is an encouraging sign that at last the keystone and foundation of railroading, the telegraph service, is beginning to receive better recognition. Instead of allowing the telegraph department to flounder along under the direction of the master of transportation or division superintendent of the road, with no electrical knowledge whatever, progressive roads now have superintendents of telegraph and division operators, who by their practical training and experience, are making great strides in the improvement of the service. When this plan is carried out generally, and when purchasing agents, who may know all the various other supplies necessary for running railroads, are relieved from the selection of electrical apparatus, a great improvement will be effected. It may appear all right from the commercial standpoint of the purchasing agent to look upon a relay as a relay, a battery as a battery, and buy those which cost the least money, but ten cents in the price of an instrument upon the effectiveness of which life and property depend from one year's end to another could not influence a practical telegrapher. Instead of forcing bad iron, bad wire, bad insulation, and clumsy, cheap workmanship into telegraph apparatus, the quality and efficiency of instruments will some day be the prime stipulation. I have seen many telegraph relays rendered almost useless for want of a proper retractile spring. This may seem a very small affair, but it is really very important. It affects the efficiency of the entire outfit and the quality of the service. Upon the quality of a relay spring depends the working of the instrument quite as much as upon the quality of the current, and yet it is only necessary to glance at the apparatus in any telegraph office to almost invariably discover that the relay spring is nearer a straight piece of wire than a spiral, and that a half turn either way will throw the relay out of operation. At the risk of having these few criticisms and suggestions ascribed to interested motives, I earnestly commend them as worthy of consideration.

I will now proceed to explain how a great improvement may be effected in the operation of telegraph lines having any considerable number of way stations. I claim that this improvement is almost as necessary to the dispatching wire as the air brake is to the train. It gives the dispatcher control of all his operators, prevents interruptions and delays, and, if the line can be worked between the terminal stations, all the intermediate offices will be in perfect working order. Their instruments will work as well in bad weather as in good. Operators cannot evade responsibility for neglect of duty or seek refuge behind the excuse that their instruments were out of adjustment on account of the bad condition of the line. Their instruments will always be in adjustment, so long as the terminal offices can communicate. This, I will, in a few minutes, demonstrate in a practical way over this miniature line, after a brief reference to the diagram of the circuit and connections which you have.

Fig. 1 shows a telegraph line extending from New York to Philadelphia, with New Brunswick and Trenton as way stations. There might be forty such stations, but these two will suffice for our illustration. The figure shows the ordinary outfit for closed circuit, single current working, the system used almost exclusively in this country, and comprising a relay sounder and key, the only adjustment being the adjuster A. This instrument consists of a magnet, armature lever l, pawl p, stops a and b, and ratchet wheel r on the shaft which carries the trailing finger t, and the circle of segments. Alternating segments are joined to a common plate, the set S forming part of the circuit, while set S' are not connected, but simply serve to make a smooth track for the trailing finger. Beginning at the Philadelphia end, the circuit may be easily traced from main battery $M\ B$ and key to segment plate S, upon which trailer t rests. From the trailing finger to relay R' through relays at Trenton and New Brunswick to New York, where it goes from relay R' to trailer t, segment plate D to key, main battery $M\ B$ and to earth. The adjuster magnets are in the local circuit with the sounders S and R. Fig. 2 is a diagrammatic view of the switch connections of the adjuster for throwing it in or out of use, as the state of the weather or line may require. $M\ M$ are the main line wires, $L\ L$ the locals. The switch is shown in neutral position. Of course it is never allowed to remain so in practice, as both the main and local circuits would be broken. Fig. 3 is a perspective view of the instrument, inclosed and ready for use.

Let us assume that the weather is fine and the line clear. The switch will be thrown to the left. The adjuster will be out of use, the line being connected outside of the trailer and segments, while a small resistance coil, shown on the switch, will be substituted for the adjuster magnet in the local circuit, the battery of which, on account of the adjuster, is increased from two gravity cells to five. While the switch is in this position we have the present ordinary organization for working. Now if a rain storm comes on, and intermediate earth route for the main batteries at New York and Philadelphia is established, and trouble with the adjustment of all the intermediate relays begins, if the escape be evenly distributed, Trenton will hear Philadelphia on a lower adjustment than that required for hearing New York, while New Brunswick will get New York on a lower adjustment than is necessary for receiving signals from Philadelphia. An office in the middle of the line would, if the main batteries were of equal strength, get New York and Philadelphia on the same adjustment, but with greatly diminished current on account of the partial ground or escape on either side of him. Ordinarily, as all telegraphers know, there is a considerable margin of adjustment. I would not be understood to state that in all cases a radical change of adjustment is necessary. It will depend on the length of the line, the number of intermediate relays in the circuit, and the severity of the storm or the general condition of the circuit prevailing at the time.

We all know, however, that on all way wires vexatious interferences and delays begin as soon as a storm sets in, and that New York might be calling Trenton, while Trenton, unconscious of the fact, might be endeavoring to get New York. When a few of these careless and inexperienced operators let themselves loose on a long line during bad weather, the use of the wire is practically paralyzed. One of these oblivious Free Lances may monopolize it for hours at a time, and it not infrequently happens that two of them, thinking the line idle, will strike up a conversation, which an unappreciative and disgusted audience of their fellows all along the line must listen to, while messages of life and death are awaiting transmission. Furthermore, operators cannot read so well when there is heavy escape on the line, because of the high adjustment required for their relays and consequent "clipping" of the signals on the sounders, owing to imperfect or light contact at the relay points. They must "break" and call for repetitions, and it often happens that rather than do this they will guess at imperfectly received signals, the danger of which, especially on railroad lines, all can appreciate. The adjusting system is designed to overcome these difficulties, with what success you will soon have an opportunity of judging.

By throwing the switch to the right, the adjuster is instantly in use. If Philadelphia opens his key, and New York be adjusted over the partial ground which I here insert between Trenton and New Brunswick* to represent a rainy day on the line, the New York relay R' will be affected, the armature pulled back by its spring, will leave its front stop and break the local circuit, in which are included the sounder and the adjuster magnets; the pawl on the adjuster lever engaging a tooth of the ratchet wheel r on the shaft carrying the trailer t', will push the trailer across the blank or dead segment of the plate S', thereby disconnecting the main battery at New York *for an instant*, during which time there is no battery on the line at either end, and consequently, no current to keep the armatures of intermediate relays attracted to their magnets. Therefore, so long as the terminal offices can communicate with each other, all the instruments between will be in adjustment and intercommunication rendered almost as easy as during good weather. The operators at these offices are not only kept aware that the line is in use, but their relays work on a much lower adjustment, notwithstanding that the opening at one end is but for an instant. The armatures of the relays having been released by this short break, will not be attracted again readily by the re-establishment of the partial ground, or not until the battery is connected again at both ends, by closing of the key. When an intermediate office is sending, the line is opened at three points, viz., the key, as long as it is held open, and at both ends for an instant.

Now if you will continue your kind indulgence for a few moments I will endeavor to give you a practical demonstration of what I have been trying to explain.

The adjusters are now switched out. We start out with a clear day. All the relays on the line have a normal adjustment and respond to the manipulation of any key Philadelphia is sending. The instruments at Trenton, New Brunswick and New York all receive the signals. By placing a lead from the line and ground wires in this jar of water we have in effect a rain storm, with its centre between Trenton and New Brunswick, making quite a heavy escape. *Now*, when Philadelphia operates his key, the Trenton instrument speaks up as before, but New Brunswick and New York are silent. New York being a head office, however, has experienced and careful operators who take precaution to try the relays on a high adjustment to see if anything is going on. Finding the line in use they adapt the adjustment to the changed condition. Now, the adjuster comes into action and wakes up our friend at New Brunswick, who would otherwise be deaf to calls from Trenton or Philadelphia, and would at the same time be a ruthless trespasser if he had a message to send. It will, therefore, be plain that the instruments at all intermediate offices must work whenever it is possible to work the line from one terminal to another, under the most delicate adjustment.

* The speaker had a model line and apparatus on the table before him.—Eds E. W.

Discussing Electrical Death at the Medico-Legal Society.

At the meeting of this society held on Nov. 21, Dr. P. E. Donlin read a paper on "The Pathology of Death by Electricity." His ideas and conclusions are as follows:

"The popular idea that the electrical current passes along the nerves and produces shock by conducting the current to the brain is, as you are aware, fallacious. Our knowledge of the great electrical conductive power of water and the experiments of Dr. Richardson, which show the still greater electrical conductive power of blood, would lead one to suppose—and, in fact, it is proved by the greater damage done to the most vascular organs of the body—that the blood is the great conductor of electricity; and that in all cases of exposure to the electric current the blood is the first to suffer and the nerve centres and cells the last.

"Unquestionably our knowledge of the manner of death points out clearly that when death is not on the moment produced by the shock of the current it must be produced by the electric current's action (conducted by the blood) upon the ganglia of the heart, causing spasm of the heart muscle, emptying the ventricles, and abnormally, forcibly propelling the charged and fluid blood to the periphery, producing hyperæmic ecchymosis in the most vascular portions of the most vascular organs.

"Where death is not instantaneous it must be produced by disorganization of the blood, interference with the circulation causing congestion of some vital vascular organ by engorgement. The lungs being the most vascular, death usually results from asphyxia, either through the unoxygenated condition of the blood or hyperæmia or engorgement of that organ."

Street Car Gear for Modern Speeds—The Coming Self-Propelled Car.*

BY S. J. M'FARREN, M'KEESPORT, PA.

A slavish adherence to precedent and deference to reputation seem to be co-operating with the ignorance too common among inventors and company officials—and perhaps with the natural conservatism of manufacturers—to produce some street railway practice curiously similar, and causelessly parallel to that of the larger railroads in which the parallel rods and counter balances of the modern locomotive embody the ideal of mechanism. One of our leading electrical companies recently had for a motto, "No inventors need apply;" and an employé's suggestion for a much needed improvement was rewarded by a sarcastic rebuke and threat of discharge.

The present increase in street railway construction has greatly increased the percentage of uninformed buyers, and made a harvest for all and every class of builders of street cars, who have with one accord exhausted their resources upon the car *bodies*, which "are seen of all men." Thus we find that the two best out of three leading street car *gears* are made by concerns which do not build *cars*. Now the gear *is* the car, as the legs and feet are the *horse*; and its neglect by manufacturers is emphasized by the severe requirements of modern speeds and mileage—doubling and trebling former practice as they do—a daily mileage per car of 150 miles and more, at a rate of 10 to 15 miles per hour being already common.

These points are especially marked in electric railway service where variations in speed are not only excessive, compared with horses or cable, but the problem is often that of *self-propulsion*. The rigidity of old gear constructions, for instance, is almost prohibitory of "self-propulsion." Those managers of electric "systems" whose worship of the subtle fluid did not entirely dwarf their estimate of the mechanical problems involved, have attained their brightest success by discriminating adaptation of devices long tried and proven on the larger railroads, and it is in this direction that we look for future progress.

Though not in the scope of this paper, the permanent way is so closely related to the rolling stock that improvement in the last pre-supposes change in the first; and it is noted in passing that general recognition is already given by equipping companies and their patrons to the need of heavier rails, of stiffer section, better alignment and surface, etc., also that the best practice dictates grooved rails on all curves and the elevation of the outer rail wherever allowed by grade of street. The utility of the last for street-car speeds was gravely questioned by a conservative engineer of an electrical company, but he has been unable to obtain any suspension of the forces of gravitation and momentum in support of his objection, or his derailed cars.

With a fit road bed, the remedy for most of the discomforts due to faulty rolling stock is so simple and easy that the public will demand it as fast as informed. Allowing that the usual diameter of wheels and height of springs are to remain unchanged, we have only to place the supports further apart (lengthen the wheel base), and the rocking or "gallop," on undulating track; also the swaying or "wag," on leaving or entering curves, disappear together if the gear is of the suspension or other flexible type. Without desiring to provoke discussion from any one who holds to the impracticability of this plan, I note that for cars longer than 20 feet, probably the best way to reach this end is that already adopted by some cable and electric roads, of using two four-wheel pivoted trucks under each end of the car, a close imitation of railroad practice. For short cars up to 18 feet, however, two axles and four wheels will continue to be the maximum, and it is to this class which we are here limited. By the adaptation of the suspension or other systems long "standard," in railroad service the wheel base of ordinary four-wheeled street cars may readily be increased 50 or 60 per cent. over present practice, with all the corresponding good results, and *without* encountering even the smallest dragon of "impracticability," so much dreaded. Not only so, but traction on curves can thus be *lightened* instead of increased, so great is the resistance of the rectangular rigidity of old style gear. It is a fact that cars of nine feet wheel base have been running successfully for 10 years on both horse and cable roads, on curves as sharp as 35 feet radius, and with unapproached economy of power and lubricant, and unexcelled comfort and ease of riding. The writer knows of one case where such trucks (four-wheeled) are carrying 30-feet cars through curves of 45 feet radius, but considers this an evident case for eight wheels, as it is safe to say that no car can ride easily with two or three times as much of its load and length *outside* of as that *between* wheel supports. Indeed, he would make the rule that *at least as much* of the car length must be *between* as that *outside* of supports, *i. e.*, only one-fourth of the entire length must be allowed to project at each end, over and past the axles. Thus a better distribution of load on bearings would be secured and neither axle would have the whole load to carry, with risk of breaking springs or wheels. A glance at the Thielsen or other suspension trucks of the ordinary passenger coach and many freight lines will show how much the suspension principle of construction must reduce flange wear and resistance. Other methods for securing flexibility are not wanting, but present limits do not permit description of them.

With sufficiently flexible gear and independent wheels it

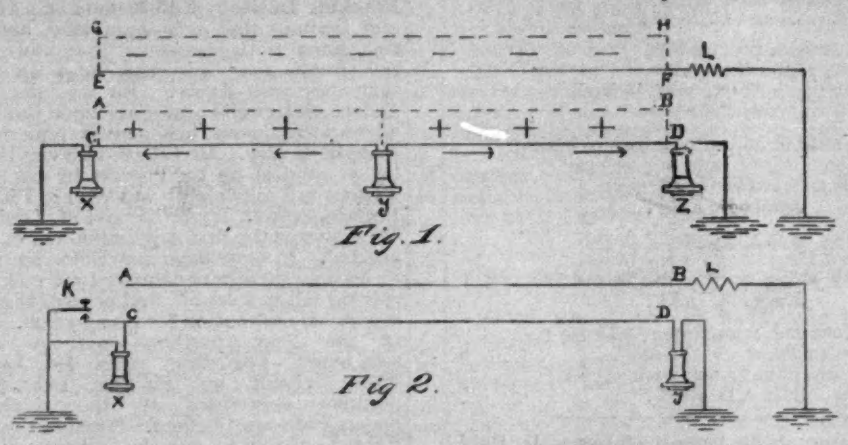
* Abstract of paper read before the American Society of Mechanical Engineers, New York, November, 1889.

is believed that present wheel base practice (6 feet maximum), can be more than doubled and *lighter* draft on curves secured. Independent wheels need not be of the "loose" type common in mines, etc., but may entirely avoid the many faults of that construction. There are many practicable forms of them which have stood severe tests in railroad service, and only failed of introduction by reason of devotion to standards and precedents and the exigencies of the "car-exchange" system, and various other limitations from which street car service is, and should be, free.

More powerful brakes are necessary for the heavier and faster running cars of the power systems. The efficiency of the track brake has been demonstrated for years on the Pacific coast, and only an attempt to dodge the Patent Office by use of wooden, instead of iron shoes, has delayed their adoption here. With them the greatest economy of wheels is secured. They should be applied by power, however. This is accomplished in a western electric system by the use of compressed air maintained by a pump geared to the axles. The car momentum may be conveniently used for the same purpose.

From even this superficial consideration of the subject its extent and importance are apparent, with the fact that there are many good points in the application of power to street car propulsion which are omitted in each of the systems now before the public. An eclectic system, chosen and adapted from these and railroad practice, would, if practicable under present commercial and legal conditions, probably cover the ground better. A modern system, for instance, which is confessedly imperfect in many points, excels all others I have seen in one particular—that of attachment to axles. This is on the differential principle, and admits not only of several changes in relative speed and "purchase" between motor and axles, but of entire disconnection on down grades to rest the motor. A friction gear was used so as to give the desired changes by the movement of the operating lever.

The coming street car will probably comprise flexible gear with long wheel base, independent wheels on (preferably) tubular axles and power track brakes. Its motors will be differentially connected. It will not only excel old practice in ease of riding and comfort, but will double the present life of wheels with great economy in track, truck and motor repairs as well as in power, lubricant, etc. This and more at schedule speeds of 10 to 20 miles per hour and without sacrifice of safety—is now in sight. The public taste and demand will become more exacting as the horse car recedes from view, and managers will more and more appreciate the fact that only the best is cheap when bidding for the good-will and patronage of intelligent people.



FIGS. 1 AND 2.—A NEW VIEW OF TELEPHONE INDUCTION.

A New View of Telephone Induction.*

BY JOHN J. CARTY.

One of the most peculiar developments connected with the introduction of the telephone was the presence of remarkable sounds which were heard when the telephone line was of any considerable length. Sometimes it sounded as though myriads of birds flew twittering by; again, sounds like the rustling of leaves and the croaking of frogs could plainly be heard; at other times, the noise resembled the hissing of steam and the boiling of water. Even a display of Aurora Borealis causes powerful currents in the telephone.

At one time, I think it was in 1882, during the prevalence of sun spots and after the appearance of a comet, the auroral current became so strong on a line from Boston to Brockton as to operate a miniature arc light which I improvised out of a pair of lead pencil carbons and connected into the line.

Some of these disturbances have been more or less satisfactorily accounted for by assuming differences of potential at the two ends of the line; by the sudden heating or cooling of the line; and by the passage of electrified bodies of air or clouds.

Another very curious effect was observed when the first two telephone wires were run parallel to each other on the cross-arms for the distance of even a few miles; it was found that although the insulation of the lines was high, a conversation carried on over one wire could plainly be heard on its neighbor. This overhearing is commonly called "cross-talk." As the number of telephone wires increased and their bunching together in cables became necessary, it was found that in addition to the cross-talk, there was another element of trouble added, which was due to the electro-static effect of the cable, and caused the voice to be transmitted in an indistinct and muffled manner. This evil exists to such an extent that where cables are used the speaking limit is soon reached.

While a study of the strange noises heard in the telephone might be of interest, I shall in this paper limit myself to the consideration of cross-talk and to the action which takes place when wires are bunched in cables. In the simple case of inductive cross-talk first cited, in which two telephone wires are strung parallel on the same cross-arm, the presence of cross-talk is said to be due to dynamic or current induction; that is, if a current commences to flow in one of the wires from north to south, it will at that instant cause an induced current to flow in the other wire in the opposite direction, from south to north. As the telephone current is constantly changing its direction and strength, this explanation seems to apply, and is the one given in the text-books.

This is the kind of induction referred to in the law of Lenz, and applies to induction coils and to parallel wires when the current is of sufficient strength. I shall speak of this hereafter as electro-magnetic induction. To-night, I shall describe some experiments which seem to prove that the induction between telephone wires is due to electro-static rather than to electro-magnetic action.

† I will first show a case of electro-static induction between telephone wires in which there is a neutral point at the centre of the secondary wire, at which point there is no induction, while at the ends marked inductive effects are noticeable.

In Fig. 1 *E F* and *C D* are two well insulated parallel telephone wires, each 200 feet long, and placed one-eighth of an inch apart. *E F* is open at one end and connected to ground at the other through a Blake transmitter *L* in the ordinary manner. In front of the Blake transmitter I place a vibrating tuning fork, which acts on the transmitter in the same manner as the voice, and which produces impulses on the line *E F* of the same strength as voice currents. At the centre of the line *C D* we have the telephone *Y*, and at the extreme ends the telephones *X* and *Z*. With the tuning fork at *L* in operation, tones are heard at *X* and *Z*, but the middle telephone *Y* is silent. A study of the changes of potential produced in the wire *E F* by the transmitter will give us an explanation of this phenomenon. As is well known, the telephone current is an alternating one, and the potential of the line *E F* varies constantly and is changed from positive to negative many times per second. The wire *E F* being open at *E* would be at the same potential throughout. It is assumed that at a given instant the height of potential at *F* would be represented by the dotted line *F H*; then the potential at *E* would be represented by the dotted line *E G*, and the total charge on *E F* would be represented by the rectangle *E G H F*. We will assume that this charge is of the minus sign. The existence of this charge on *E F* presupposes the presence of a charge of opposite sign on *C D*, which would be represented by the rectangle *A C D B*.

Now, suppose the potential on *E F* becomes zero, owing to the operation of the transmitter, then the whole charge on *E F* gets to earth at the grounded end of *E F*, but the charge on *C D* has two paths to earth, one at *C* and the other at *D*. This results in two currents, as shown by the arrows, one flowing to earth through the telephone *X* and producing sound at *X*, and the other flowing to earth through the telephone *Z* and producing sound at *Z*. No current flows through the telephone *Y*, and consequently no sound is produced therein. Again, changing the potential of *E F* causes a corresponding set of currents, but in opposite directions to those first described, meeting in the centre and producing no sound in the centre telephone, but causing the end telephones to give out sounds the same as in the first instance. Inasmuch as the line *E F* is opened at one end and therefore has almost an infinite resistance, it is clear that this phenomenon is purely an electro-static one.

In this and the succeeding experiments I have not attempted to give the exact shape of the induced charge, as it would unnecessarily complicate the subject and would not in any way affect the result. As a matter of fact, the dotted line *A B* should slope off from the centre toward the ends.

With the line *E F* grounded through an ordinary subscriber's line and instrument, the effect is the same as when the line is open, and the neutral point is still found. This is because the telephone current, even when flowing in a closed circuit, is so weak that it is not capable of producing a magnetic field of sufficient strength to affect the neighboring wire, or the magnetic effect is so small that it is obliterated by the movement of the static charge. For convenience in some of the succeeding experiments, the disturbing wire will be shown open at one end.

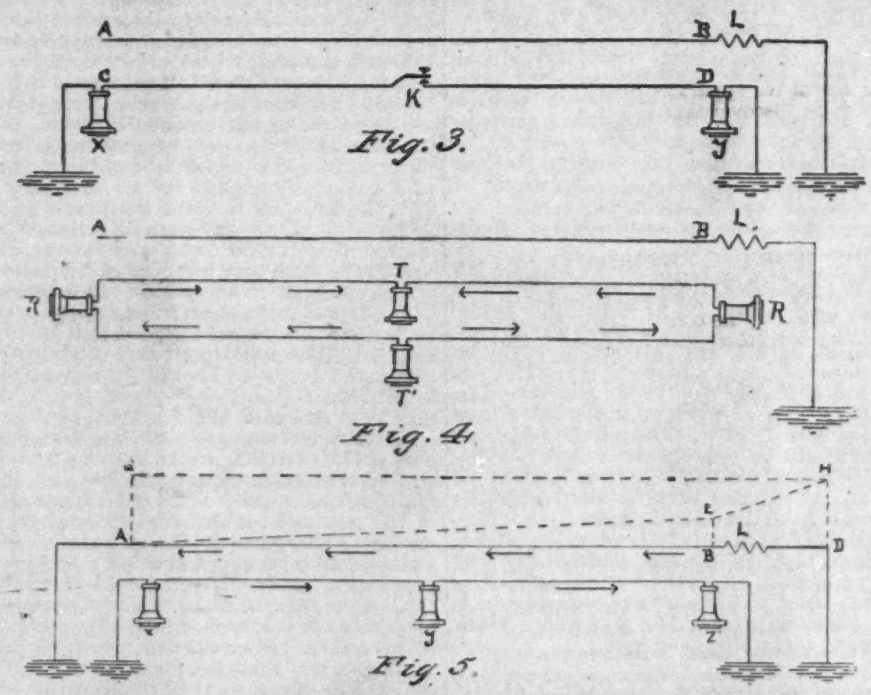
If there is no current flowing at the neutral point, opening the wire at that point should have no effect on the telephones located at the ends. In Fig. 3, *A B* is the disturbing wire with the transmitter *L* arranged as before; *K* is a key located at the neutral point of *C D*. With the transmitter *L* in operation, no change is produced in the tones heard at the telephones *X* and *Y* by opening and closing the key *K*. If this induction were electro-magnetic, opening the line *C D* would prevent current from flowing in any part of the circuit. In Fig. 2 we have another proof of the electro-static nature of telephone induction. *A B* is the usual disturbing wire with its transmitter *L*. *C D* is the secondary wire with the telephones *X* and *Y* located at the ends, as in the previous experiments. By means of the key *K*, the telephone *X* may be cut in and out of the circuit. With the key open, the usual tones are heard at *X* and *Y*. Now, if the induced current flowing in the circuit *C D* is due to electro-magnetic induction, upon short circuiting the telephone *X*, and thereby reducing the resistance of the circuit *C D*, the strength of the induced current should be increased and the tone at the telephone *Y* should be correspondingly louder. But this is not the case, as on closing the key the sound at *Y*, instead of being increased, entirely disappears. This is because the charge on the wire *C D* finds an easy path to earth through the key, and such a small portion of the charge goes to earth through the telephone *Y*, that no audible effect is produced therein.

Fig. 4 shows the disturbing wire *A B* arranged as before, but the secondary wire instead of being put to earth at both ends, has its circuit completed by a second wire placed outside of the field of *A B*. With this arrangement, neutral points are found at *T* and *T'*, while the usual disturbances are heard at telephones *R* and *R'*, located at the ends. In this case a movement of the static charge takes place in the metallic circuit, causing at one moment a set of currents starting from *T'* in both directions through the end telephones and meeting at *T*, and at the next instant the reverse takes place.

I will now show some of the effects of electro magnetic induction, at the same time suppressing electro-static induction.

In Fig. 5, *A B* is the disturbing wire as before, but grounded through a short thick wire at *A*. Instead of placing the tuning fork in front of the transmitter *L* and acting on it through the air, producing delicate currents like voice currents, an automatic circuit breaker and five cells of Leclanché battery were connected in the primary circuit of the transmitter, thus producing in the line *A B* alternating currents of great strength. The secondary wire containing the telephones *X*, *Y* and *Z* is of the same length and at the same distance from the disturbing wire as in the previous experiments. With the circuit breaker at *L* in operation, loud musical tones are heard at *X*, *Y* and *Z*, and the tone is the same in all three telephones, the neutral point in this case having disappeared. This is a true case of electro-magnetic induction, because short circuiting the telephone *Y* increases the sound in the remaining telephones, and leaving the short circuit on *Y*, and short-circuiting the telephone *X*, still further increases the sound at *Z*. This latter experiment furnishes a most striking contrast to the result obtained in Fig. 2, where by short-circuiting the telephone *X*, the sound was completely removed from the telephone at the other end of the line.

Another proof that this is electro magnetic induction is found in the fact that if the line be opened at *Y* the sound disappears from all the telephones. If the line *A B* were opened at *A*, the potential along the line would be constant, and the charge which *A B* would take would be represented by the rectangle *A G H D*; but when the line is grounded at *A* through a low resistance, there is, of course, a fall of potential along *A B*, the principal drop, however, occurring in the secondary coil of the transmitter *L*, the line *B E* re-



FIGS. 3, 4 AND 5.—A NEW VIEW OF TELEPHONE INDUCTION.

* A paper read before the New York Electric Club, Nov. 21, 1889.

† In explaining an experiment of Mr. Culley before the Society of Telegraph Engineers in 1875, Mr. Preece pointed out that in a certain telegraph line subjected to induction from a neighboring telegraph line, there was a neutral point. I can find, however, no reference to this in Mr. Preece's book on "The Telephone," and its practical application to telephone induction seems to have been lost sight of.

presenting the height of potential at the terminal of the coil, and the electro-static effect which the line *A B* would have is represented by the triangle *A E B*. This triangle, although exaggerated in the diagram, is still much smaller than the rectangle *A G H D*, and explains the absence of electro-static induction between the wires, while the powerful current generated in *L*, and the comparatively low resistance through which it has to flow, accounts fully for the electro-magnetic effects observed.

I have made a large number of laboratory experiments and observations on actual telephone lines, all of which point strongly to the conclusion that electro-magnetic induction does not exist in telephone lines outside of the telephone and transmitter. This view of the subject applied to the theory of transpositions of metallic circuits and to the action of wires in cables, gives the only satisfactory explanation of the observed phenomena.

Now, we come to the important question: Can this electro-static induction be prevented? In answer to this, it can be said that the cross-talk due to electro-static induction can be eliminated by properly constructed metallic circuits. But there still remains the muffling effect referred to in the first part of this paper. This is sometimes called "electro-static retardation," and comes in whenever two telephone conductors are run close to each other for any great distance. Where telephone wires are strung upon poles, and are at a distance of a foot or more from each other, this action is very small, but where they are bunched together in cables, a hundred or more within a two-inch pipe, it is very great. It is a curious fact, however, that the amount of this trouble, other things being equal, depends on the character of the insulating medium, or dielectric, as it is called, but is independent of its specific insulation resistance, the induction being less when air is used as an insulator than with any other substance among the materials adopted in practice. Dry cotton, paper and silk rank next to air in this respect, but when gutta percha or any of the rubber compounds are used, the induction is much greater than with the other materials mentioned. This peculiar property of an insulator, *i. e.*, the facility with which it allows induction to take place through it, is called its "specific inductive capacity." In the present state of the art, then, the only way to overcome electro-static retardation, after having an insulator or dielectric of the lowest specific inductive capacity, is to increase the distance between telephone conductors. It is evident that in underground systems this distance can never be great. In all of our large city underground systems the space which is allowed for each wire is .125 of an inch.

This putting wires underground in cities is the only bar to a universal system of telephony, and if direct air lines were built New York and Chicago would be placed within speaking distance of each other at once.

To place telephone wires underground and maintain the same efficiency as in overhead lines, would require an insulation on each wire of over two feet in thickness, and instead of getting 50 pairs of wires into a three-inch pipe, as at present, a tunnel occupying half the street would be required for one cable alone. When we consider that a telephone office of even moderate size would require about a hundred such gigantic cables, it is seen how almost hopeless the case becomes.

Most engineers think that this difficulty is inherent in the problem, and that the electro-static action can only be overcome by separating the wires as already stated.

In view of the recent researches tending to give us a deeper knowledge of the nature of electricity which have been conducted by Hertz and others, I think there is reason to hope that some other way out of the difficulty may be found. You are all, no doubt, familiar with those celebrated experiments wherein electrical undulations of many million times per second were produced, and, although they were transmitted along a conductor with the velocity of light, yet they followed each other with such rapidity that nodal points were produced, the location of which determined the length of the waves. These waves have been produced in various ways, and by means of large prisms of pitch and by metallic mirrors they have been refracted, focused and reflected. In fact, they have been found to obey much the same laws as light waves.

I think it must follow from these experiments, that our disturbing wire *A B* is throwing off, laterally, waves of great length, and that these waves, impinging upon the adjacent wire *C D*, produce the various inductive effects observed.

Now, if by some means, these waves could be deflected from their course and prevented from falling on the wire *C D*, it follows that there would be no disturbance whatever produced therein. We know that if these waves were of the same length as light waves, this action could be prevented by the interposition of a properly-shaped lens of glass, or by a mirror; or if they were of the length used in Hertz's experiments, a lens of pitch or a metallic mirror would have the same result. Now, although the telephone waves are of great length, it seems possible that by interposing a properly-shaped dielectric or combination of dielectrics, that an interference or refraction might be produced which would have the desired result.

This electro-static problem is one of the most important, and until within a year or two, the least studied, and is at present the least understood of all the various difficulties with which we are confronted, and the reward which awaits its proper solution is greater than that which fell to the lot of the inventor of the telephone itself.

In the discussion which followed the reading of Mr. Carty's paper, Mr. Bradley suggested that the phenomena observed might be only a question of degree, and that the electro-static charge was produced by the electro-dynamic induction, the capacity of the wire being sufficient to absorb the charge when the impulse is of very low degree. Mr. Carty, however, adhered to his opinion, based on his experiments, that electro-dynamic induction was entirely absent, and not to be considered.

Mr. Carty also referred to the observed fact that although telephone wires might be shielded from the electro-dynamic induction of neighboring electric light wires, the electro static induction might nevertheless cause disturbance, and hence the trouble often experienced on lines which appear to be run in strict accordance with the principle of having the outgoing and return wire at equal distance from the telephone wire; or in other words, an electro-dynamic balance does not necessarily imply an electro-static one.

In reply to a question of Mr. J. A. Seely, Mr. Carty said that even with wires twisted in pairs neutral points were observed, as indicated in Fig. 1.

The discussion was also participated in by Messrs. Garratt, Wetzler, Field, Davidson and Reed.

To James Douglas Reid.

Lines Written on the Occasion of a Farewell Dinner to the Hon. James D. Reid, U. S. Consul to Dunfermline, Scotland, November, 1889.

Snowy-headed, summer-hearted,
From you so soon must we be parted,
Then let us here bid ye God speed!
James D. Reid!

Friend of Morse and friend of Orton,
Friend of every man you've thought on:
Living out the Saviour's creed,
James D. Reid!

Of our great Art, your noble story
Reveals the pathos and the glory;
Honors in turn shall be your meed,
James D. Reid!

Your care it was to soothe the sorrow
Of the poor fatherless and widow;
A helper in the hour of need,
James D. Reid!

Nestor, author, poet, artist,
Diplomat, philanthropist;
There's many a side to you, indeed,
Jamie Reid!

Back to auld Scotland now you're hieing,
Despite our protests and our sighing,
Methinks ye'll hardly be forgied,
James D. Reid!

Remember us in the coming days;
Forget not Broadway on the braes,
Nor Forth along, nor by the Tweed,
James D. Reid!

Jamie, dear lad, may peace and ease
Attend your lot across the seas;
Your luck will ne'er our wish exceed,
James D. Reid!

Farewell Banquets in Honor of James D. Reid.

Mr. James D. Reid, the well-known veteran telegrapher and historian of the telegraph in America, has been appointed United States Consul at his native place, Dunfermline, Scotland, and leaves for his post on Nov. 27. In view of his departure, two banquets were given him last week. The first was tendered him by the Magnetic and Telegraph clubs, of this city, on Nov. 20, at Martinelli's restaurant, on Fifth avenue, and was attended by no fewer than 140 gentlemen. Not only were the above clubs well represented, but members were also present from the Telegraphers' Mutual Benefit Association; the New York Electrical Society; the American Institute of Electrical Engineers; the New York Electric Club; the Old Timers' Association and other bodies.

After a few introductory remarks by Mr. C. P. Bruch, the President of the Magnetic Club, the banquet began, Mr. W. J. Dealy presiding, with the guest of the evening on his right hand. The benediction was asked by the Rev. C. A. Meredith, who was once a messenger boy at 145 Broadway. When the cigars had been lighted, Mr. Dealy rose and said:

Kissing the cross hilt of his sword, the soldier of old saluted, and at the same time and by the same act, swore allegiance to his king. To-night we grasp the hand of this honored veteran, Mr. James D. Reid, that by the *connection* he may feel the thrill of an *impulse* from all along the *line* of an army, the grandest that the world has ever known; and that he may *receive* from every member of its rank and file in the *electric signal* which he gave us over forty years ago, the salute that now is known as the *magnetic* "73." Our allegiance is manifested by our love. Where is the king whose crown is as jeweled as his? As Americans we are proud of the statue in New York harbor, Liberty Enlightening the World. But as telegraphers we are prouder of the invention that civilized it. *Trace* backward to the dawn of the *wires*, *call* up the struggles of the pioneers, stare if you will in admiration of the *character* of the man, who was superintendent No. 1. Note how he *charged* the Old Timers with the faith that was within him, and how by his wit and tact and story he removed every *cross* that *interfered* with their comfort or *interrupted* their march to success. The very mention of his name among them brings up from memory's joyous fountains the sprays of life's elixir to make them "just as young as they used to be." Were I to *report* the good that Mr. Reid has done, it would be but *repeating* what illuminates every page of telegraphic history. Look at the organizations represented here to-night—the Telegraphers' Mutual Benefit Association, the oldest of them all, his certificate No. 1, and so on down to the youngest, the New York Telegraph Club, its book-shelves bending with donations from his library. And now he is about to temporarily leave us; and while we congratulate him upon the honor of his appointment to represent in his native land his adopted country, we congratulate also those who selected him, and more than all, those into whose midst he is about to enter. And yet we would have been glad if the *transfer* had not been made. But although an ocean may separate he will still be with us; he cannot forget "what God hath wrought"—nor the forty-five years of his *service* on *circuits* that have proclaimed it—nor can we forget, nor shall we, the kind words, the cheery greetings, the timely lessons and the Christian acts of Mr. James D. Reid, whose heart was never known to throb but for the welfare of his fellow-man, and who was the bosom friend of Morse.

Mr. G. E. Holbrook, president of the New York Telegraph Club, then spoke briefly, and was followed by Vice-President,

Mr. F. W. Greene, who said that they were that night adding some important pages to the history of the telegraph in America. He passed a high eulogy on Mr. Reid, and mentioned that the library of the Telegraph Club included 45 choice volumes, a gift from that generous hearted man. In behalf of the club, Mr. Greene then presented Mr. Reid with a beautiful gold medal.

The presentation was accompanied by a perfect whirlwind of applause that lasted several minutes, after which

Mr. James D. Reid made a most interesting speech, full of pathetic and humorous reminiscences of the early days of the telegraph. He said that he was 70 years old on the 22d of March last, and often had felt that his life had been a failure, but when he encountered such a magnificent reception he was reassured, and ventured to believe that he had not lived in vain. He could also say that he felt better in health than he did four years ago, and that he was farther than ever from gratifying the wish one of his friends near by had of delivering an oration over his remains. He then went on to speak of his close association with Morse, and defended the memory of the great inventor with much force and eloquence. With regard to his own connection with the development of the telegraph, he was proud to believe that he was the first man in all the world to learn the Morse telegraph without an instrument. He opened the first telegraph office for commercial purposes in this country. He was the first to show the practical danger of the electric current, by knocking over into a puddle an assistant who was testing a break out on the line with his tongue. He was the first man who tried to insulate a telegraph wire by covering it with tar. (Laughter.) He was the first man to introduce iron wire into the telegraph service of America, and he put up the first circuit of it himself. He was proud to have been the first superintendent that appointed a woman to a telegraph office. He was the first man to devise means for protecting the circuits from lightning, and was presented with a silver medal for the invention by the Franklin Institute of Philadelphia. Then he was the first and perhaps the only man who undertook to insulate the lines with beeswax (laughter), so that it was the finest time for the bees in the neighborhood that they ever knew. He was the first man who ever undertook to write a message upon the water of a canal, which was supposed to be a great thing then, but is not much thought of now. He believed he was the first in this country to connect up the circuits in one, so that the signal written in Philadelphia was read in Pittsburgh, Cleveland, Buffalo, Detroit, Louisville and St. Louis at the same time. Then he was the first superintendent of telegraphs ever appointed. In those days superintendents were scarce, and he became superintendent for four companies at once, receiving salary from all, and none of them would consent to accept his resignation for many years. He did all the work of the four positions without any clerical help whatever. For five years he kept the telegraph offices closed on Sunday, but at last the imperative necessities of the work compelled the opening of some of them. Some of the papers had lately figured out that he was the first man to send a president's message, and that evening a letter had come from an old friend who had received the message. He remembered that it took fourteen long hours, all through the weary watches of the night, Mr. Reid then told the amusing and now celebrated story how he sent another message, that by President Polk in the time of the Mexican war in 1848, when Santa Anna was issuing his pronunciamentos. Tired out and glad the work was done, Mr. Reid wound up the message by adding "God and Liberty" before "James K. Polk." There was an immense sensation, and Prentice, of the *Louisville Journal*, wanted to know what Polk had to do with either God or Liberty. In spite of the storm raised, he could not very well dismiss himself. (Laughter.)

Mr. Reid, after dwelling on these reminiscences with modesty and much humor, went on to say that he had always sought to make kindness his weapon of discipline. When he went into an office he had made it a point to shake hands with all down to the smallest messenger, and he always knew that any request he made would be respected. He was glad to have been instrumental in organizing the Telegrapher's Mutual Benefit Association, which had been so useful and helpful. He then referred to his appointment as Consul at Dumfermline, which he had not sought, but came to him through the agency of a sweet-minded woman whom he greatly respected—the wife of Andrew Carnegie—whom he had befriended as a messenger boy at Pittsburgh in 1847, and whose rise to wealth and fame they had since witnessed. He concluded by saying that he would carry with him to his new sphere of work the tenderest recollections of his friends in the telegraph service in America. (Great applause).

At this point, pipers in Highland costume came in and played a selection of Scottish airs.

Mr. T. P. Scully then made an admirable brief speech in well-chosen phrase, and described himself as an admirer of Mr. Reid of thirty-eight years' standing.

Mr. S. S. Garwood spoke for the Telegraphers' Mutual Benefit Association, and dwelt upon the esteem that Mr. Reid had won for himself in the telegraphic ranks by his good deeds.

Mr. Reid rose again to acknowledge the tribute, and referred touchingly to the accident which had disabled him, practically, for so many years. A watchman chasing a slave at Louisville, one day in 1853, when Mr. Reid was walking through the street with Mr. Dealy, threw a brick at the fugitive. It struck Mr. Reid, and the blow brought on an illness that threatened his life and resulted in long and serious incapacity for heavy mental work. It was only within the last few years that he had really felt himself again, so that he could work as of old, and be equal to other than the subordinate positions he had been restricted to by the disablement.

Mr. E. C. Cockey then gave a speech and a story or two, with bagpipe obligato, and Mr. R. C. Edwards spoke on behalf of the New York Telegraph Club.

Mr. F. W. Jones, as a friend of Mr. Reid for 22 years, paid a high tribute of respect to him, and cited several passages from the *Journal of the Telegraph* to show what had been Mr. Reid's work as its editor and as the father of the "T. M. B. A."

At this point a large number of telegrams were read which had come over a special wire run into the banqueting room from the Western Union office, including ones from H. B. Chamberlain, C. E. Taylor, A. B. Cornell, Andrew Carnegie, J. H. Wade, S. B. Gifford, W. J. Lloyd, W. R. Plum and many others. Among them was this from Mrs. M. E. Randolph in behalf of the "sisterhood":

We hail thee, honored chieftain! let thy brow
Be crowned with laurel wreath, thy country's meed,
In recognition of the loyal heart
And hand, that weary not with worthy deed.
From the warm shelter of our reverent love
We send thee forth! In "hollow of His hand,
'Neath shadow of His wing," thy home shalt be.
What, though fierce storms abound and tempests rage!
Thy bark will reach the haven of His love.

When thoughts of home and absent friends are thine,
Look out upon the stars, and name them o'er;
The brightest and the best shall bear to thee
Our kindly thoughts, the incense of our prayers.
Thy mission hence accomplished, added gems
Will give new radiance to thy crown; and we
Will gladly welcome "home again" the friend
Whose life inspires glad hopes of God and Heaven.

Mr. G. H. Usher then made a short speech and was followed by "Senator" W. L. Ives, who as usual convulsed

his audience with laughter. Mr. Ives gloried in the fact that he had been the only operator Mr. Reid had ever dismissed. The cause was an effort on his part to combine matrimony and telegraphy with farming, but Mr. Reid had quickly given him another position, and he was there to testify his affection for his old friend.

Between the speeches, songs by Mr. Lewinson and recitations by Mr. Ballantyne were interspersed.

The proceedings closed with "Auld Lang Syne" to the music of the bagpipes, after which Mr. Reid shook hands with all present.

The second dinner in Mr. Reid's honor, that given by the Western Union officials and his personal friends, came off at the Fifth Avenue Hotel, on Nov. 22, in the large dining hall, which was handsomely decorated with English and American flags and the Scottish coat-of-arms, and was presided over by Dr. Norvin Green, who sat with Mr. Reid and L. M. Lawson at his right and Andrew Carnegie and Gen. Eckert at his left hand at a small table on the dais at the east end of the room.

Seated at the four long tables facing them were nearly one hundred of Mr. Reid's friends, including Gen. Wager Swayne, Samuel Sloan, A. B. Chandler, R. H. Rochester, A. R. Brewer, O. D. Baldwin, Horace Winans, Henry C. Vedder, Edward Colgate, John P. Townsend, J. A. Bostwick, John D. Rockefeller, Theodore M. Banta, the Rev. Dr. Bridgeman, L. H. Niles, James B. Colgate, Wilson G. Hunt, David Brooks, John Van Horne and E. C. Cockey. Many telegrams and letters of regret were sent in from all over the country, and among those read by Thomas F. Clark were two from Cyrus W. Field and Erastus Wiman.

The menu was elaborately gotten up in parchment. A device of a hand and a telegraph key ornamented the cover; several pages ruled for autographs followed the dinner card, and the leaves were bound together with bits of well-insulated copper wire.

In proposing "The Guest of the Evening," Dr. Green spoke for a moment of his friend's history, concluding by saying that if he had done nothing else in all his life other than the founding of the Operators' Telegraph Mutual Benefit Association he had done enough to immortalize him.

Mr. Reid's response was mainly in a reminiscent vein, and was on the same lines as that given above.

Other speeches were made by Andrew Carnegie, A. B. Chandler, Gen. Eckert, and John D. Rockefeller.

Mr. Reid sails for Scotland by the steamer Lahn on Wednesday, Nov. 27.

On Saturday afternoon, Nov. 23, the ladies employed in the various telegraph offices in this city waited on Mr. Reid, at the Western Union Office, and overwhelmed him with flowers and kind farewells.

A Good Month for Electric Railways.

This is the time of the year when most railway contractors and the companies engaged in outside construction work complain of inactivity and lack of orders. The summer excursion season for street railways is over, and the custom of those who patronize the street railways for pleasure purposes only has decreased rapidly to a point where it cannot be depended upon to yield much profit. Outside construction work becomes arduous, and in some places will be soon almost entirely impracticable. It is very gratifying to those interested in the adoption of electric street railways to appreciate that though to a great many companies doing outside work, business had been dull, the prominent electric railway supply companies have not felt the usual depression.

The Sprague Electric Railway and Motor Company have, during the last month, closed the following contracts for street railway equipments: Sioux City, Ia., Electric Railway, 12 cars; Sherman, Tex., College Park Electric Belt Line, 5 cars; Newark, O., Electric Railway, 1 car; Milwaukee, Wis., West Side Street Railway, 10 cars; Nashville, Tenn., & Edgefield Railway, 10 cars; Nashville, Tenn., South Nashville Railway, 10 cars; Salt Lake City, Utah, Electric Railway extension, 10 cars; Youngstown, O., Electric Railway, 6 cars.

In spite of the season of the year, the contracts of this company go on increasing, and a very large amount of construction work on their many railways will have to be carried on without intermission right through the winter, for extensions of old roads, or upon railways which have never before been equipped with electricity, and which have adopted the Sprague electric system.

The business of the Sprague Company is now of enormous proportions, and the factory of the Edison Machine Works at Schenectady is crowded with orders for motors and power dynamos. The large number of contracts for street railway equipments closed by this company during the last two or three months has been remarkable and noteworthy.

Annual Meeting of the American Society of Mechanical Engineers.

The twentieth meeting of the above society was held in this city last week, and was probably the best attended and most interesting that the organization has known. The proceedings began on Monday evening, Nov. 18, with a reception at the new rooms of the society, 64 Madison avenue, and the work throughout the week was agreeably interspersed with banquets and excursions, one of which was to Willett's Point, to witness the electrical torpedo practice there. A number of interesting papers were read and discussed during the sessions.

Mr. Oberlin Smith has been elected president for the ensuing year. Retiring President Towne made an interesting address, in which, while urging the undeniable claims of New York as the proper place for the Columbus Fair, he counseled delay of one year. The society approved his suggestion that there should be a grand celebration and the unveiling of a statue of Columbus in 1892, and that the fair itself should open in 1893.

Mr. Towne also presented one of the most important measures introduced during the meeting. It provided for a new organization, and after stating the fact that there are four associations of American engineers in the country; that many members of each society are desirous of forming a new organization which would not disturb or supersede those already in existence, but will be broader and more comprehensive, more representative and national in character; that it can be accomplished without any encroachment on the autonomy of the existing organizations, and that it is especially desirable, in view of the contemplated international exhibition in 1892, that there be some organization representative of American engineers and qualified in their behalf to receive and entertain the foreign engineers who will probably visit America, and also the desirability of closer relations between the members of the existing organizations, it ended by resolving:

First—That the American Society of Mechanical Engineers views with favor all efforts tending to establish more intimate relations between the existing engineering societies, and to develop a national organization of American Engineers.

Second—That to promote this object the council be hereby requested to communicate these resolutions to the officers of other engineering societies, and to invite them to unite in a discussion of the subject, and in an endeavor to reduce it to proper form for submission to the consideration of the membership of each society.

Third—That to this end the council be further requested to appoint a committee of three members to represent this society in any such conferences to consider the whole subject herein referred to, and to report the result of their labors to the next meeting of the society.

This brought out considerable discussion, but after it was clearly explained it was adopted unanimously. The importance of this move will be seen at once when the fact is known that the four engineering organizations, which embrace mining, electrical, civil and mechanical engineers, number about 4,500 professional men, whose union would make an organization at once powerful and beneficial not only to its members but to the entire country.

Mr. Sunny on the Use of High-Tension Currents.

At the last meeting of the Chicago Electric Club, Mr. B. E. Sunny read an interesting paper on "The Use of High Tension Currents in Electric Lighting," in which he took as the basis of his argument the recent article of Mr. Edison appearing in the *North American Review*. Mr. Sunny characterized the statements contained in that article as sweeping and sensational, and as many were largely interested in some of the systems attacked he felt it his duty to make some reply to them. Mr. Sunny condemned the New York practice of allowing politics to enter into the attempted regulation of the circuits.

Referring to the classification of the circuits made by Mr. Edison into safe and dangerous, Mr. Sunny showed that it, if carried out, would mean the abandonment of about 300,000 arc lights and about 400 central stations furnishing nearly 2,500,000 incandescent lights by the alternating system. Of these Mr. Sunny claimed that only two per cent. were in New York, and it was unjust to saddle upon the entire country the burdens due to errors made in New York City. Continuing, Mr. Sunny said:

"Mr. Edison's reason for opposing the placing of the high-pressure wires underground is that there is no known insulation that will confine this class of currents for more than a limited period, and then will result earth contacts, the fusion of wires, 'the formation of powerful electric arcs, which will extend to other metallic conductors in the same conduit, and the whole mass of wires made to receive this dangerous current and convey it into houses, offices and stores.'

"In connection with this statement it must be borne in mind that up to within two or three months no high pressure wires were put under ground in New York, and that Chicago was the only city undertaking to furnish service in this manner. Mr. Edison's statement can therefore not be based on practical experience, but on surmise or lack of information, for the reason that for two years or more underground conductors have been working in the conduits in Chicago without any more disastrous results than an occasional grounding in a defective joint, which was readily and rapidly repaired. Nor are there any signs of the deterioration in the results of the cables used. On the contrary, everything points to the continued usefulness of the wires for an indefinite period. Mr. Edison's claims that high-pressure wires cannot be operated underground, therefore cannot be regarded as a final settlement of the question.

"Mr. Edison says that there is no justification for the use of high-pressure currents 'either in the scientific or commercial sense.' Happily Mr. Edison is not supported in this view, either by the public, the electric people, or his fellow-stockholders in the Edison Company. The commercial necessity for the high-pressure currents is most pronounced and indisputable, and for no purpose is it in greater demand than for incandescent lighting, where it comes in competition with Mr. Edison's system. Mr. Edison says it is used to avoid the large expenditure necessary for real estate and copper called for by the low-tension system, for the reason that the station using the latter must be put in the centre of the district lighted, while if the high-pressure system is used, cheap land at a considerable distance will answer the purpose as well. This is not a fair statement, for the reason that the first cost of the plant is in many instances disregarded entirely, and the cost of operation made the important question. The high-pressure system permits the placing of the central station at any part of the city, so that coal can be unloaded directly from the cars; so that water can be had for condensing engines—two items alone which mean a saving of forty per cent. in the cost of operation. The loss of electrical energy, amounting to twenty per cent. or more in the Edison system, is reduced one-half or two-thirds by the use of the high-pressure system, while the crowning feature of the latter is the adaptability and practicability for lighting unlimited territory, including the residence district in each city and the suburbs. All this can be done from one central station, and at a cost that makes it possible to gauge the price so that it costs no more for a good electric light than for an indifferent gas jet."

Mr. Sunny concluded as follows:

"It is vastly to the advantage of the electric light service that a great many customers and a large quantity of light can be furnished by the use of a few wires, while for the telephone service it requires a separate wire for each telephone. If the few wires required for electric lighting are put up well and are well insulated and the telephone and telegraph wires are removed, there ought not to be the slightest objection to the electric light wires, and I think there will not be. If, however, the electric light wires are in large numbers on principal thoroughfares, or at points where they leave the central station, and it is advisable to place them underground to improve the appearance of the streets, I very firmly believe that it will not be very long before enough will be known by every man interested in the electric light service, regarding the correct methods of handling these high-pressure currents underground, so that there will be no hesitation in so disposing of them."

After a lively discussion, in which Messrs. Degenhardt, Sperry, Cutter and Badt took part, Mr. Sunny offered the following resolution, which was carried:

Resolved, That, it is the sense of the Chicago Electric Club, that the objections to, and the general condemnation of, the high pressure systems of lighting set forth by Mr. Edison in an article in the November number of the *North American Review*, are not sustained, and that the growth and popularity of the service furnished by this class of currents are in themselves a contradiction of Mr. Edison's conclusions; and further, be it

Resolved, That with proper construction and exercise of reasonable intelligence, the high-pressure currents are absolutely safe.

Annual Meeting of the Telegraphers' Mutual Benefit Association.

The annual meeting of the above association was held at the Western Union office, 195 Broadway, on Nov. 20.

The report of the secretary showed a membership of 3,452, and in the second division 409, a net increase of 55 in the first and a net loss of 67 in the second division. There were 27 deaths during the year, of whom eight were members of the second division. One hundred and thirty-eight lapsed and two resigned.

The treasurer's report showed the death claims paid amounted to $28,000, against $34,000 last year. The general expenses were $3,397.63, against $3,685.58 last year. There was added to the reserve fund $14,350. The par value of the reserve is $87,050; market value, $88,500.

Mr. W. J. DEALY offered the following resolution:

WHEREAS, As shown by the report of the secretary and treasurer of the second division, the membership has fallen from 476 to 409 and the amount of benefit from $433.58 to $372.60;

Resolved, That this meeting strongly recommends the abolition of the second division, and to secure that end advise its members to resign their membership in that division.

After some discussion, Mr. Young requested the decision of the chair as to the resolution being out of order, and the chairman so ruled.

On motion of Mr. Sabine it was

Resolved, That the subject of the continuation of the second division be referred to the Executive Committee.

The new officers elected were: President, James Merrihew; Vice-President, W. H. Young; Secretary, Thomas E. Fleming; Treasurer, G. W. E. Atkins. Executive Committee: James Merrihew, G. W. E. Atkins, T. E. Fleming, W. H. Jackson, J. L. Edwards, New York; W. B. Gill, Philadelphia, Pa.; W. H. Young, Washington, D. C.; C. W. Hammond, St. Louis, Mo. Auditing Committee: S. S. Garwood (chairman), Philadelphia, Pa.; M. J. O'Leary, W. J. Dealy, New York.

President Merrihew's address made allusion to the good work done by Mr. C. P. Bruch as secretary, and spoke with satisfaction of the increase in the reserve fund.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Nov. 23, 1889.

Chas. A. Schieren & Co., of this city, have received a contract to supply four perforated "electric" leather belts for the new plant being put in for lighting the United States Senate Chamber at Washington.

The Star Electric Construction Company are contractors for arc and incandescent lighting. They put up private telephone lines, and construct all kinds of household work. Martin H. McGarry is the manager, 1623 Fulton street, Brooklyn.

Arc Light Clamp Litigation.—The United States Supreme Court has sustained the decision of Judge Shipman, given some time ago, declaring the Brush claim on the annular clamp invalid, on the ground of the prior use of the Hayes' rectangular clamp.

The Wenstrom Northern Electric Company have issued invitations to examine the new Wenstrom motor shown at the American Institute Fair, being the first of the kind built in the United States. They claim that it is "the standard and future motor for car traction and all enterprises requiring heavy and constant work."

Storage Battery Litigation.—The Electrical Accumulator Company have moved for an intervention in the Brush-Julien suit, which is now awaiting the decision of Judge Coxe, on the ground of collusion between the litigants, it being now understood and claimed that an arrangement or contract exists between the Julien and Brush Companies.

A. Gardam & Son have moved to 98 John street, where they undertake all kinds of mathematical work, models, etc. They are noted as makers of mathematical instruments, marine and land compasses, electrical and mechanical apparatus, models, surveying instruments, etc., and have produced a great number of interesting pieces for leading inventers.

The Peckham Street Car Wheel and Axle Company, of this city, with reference to a contradiction we have received from Mr. Manier, write us that instead of having, as stated, the exclusive right to the Manier brake, they have the right, outside the Gilbert Car Company, for the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Ohio, Michigan, Illinois and Indiana.

The Electrical Repair Assurance and Construction Company is a new concern recently started uptown at 1,267 Broadway. They take charge of electrical fixtures, etc., in private houses, buildings, etc., and for a fee of 25 cents a month and upwards guarantee to keep things in good running order. Extra charges are made for repairs of damage or renewal of fixtures. Construction work is also undertaken. Mr. S. B. Pratt is the general manager; C. T. Ross, superintendent and electrician, and Mr. E. J. Douglas, superintendent of outside construction and application.

Mr. M. M. Haydon, of the Law Battery Company, 85 John street, has just returned from a trip as far as Kansas City, and reports very successful sales of their new battery. Wherever it has been in use any length of time it has given great satisfaction. The output of Law batteries has doubled every year, and has already done so again up to the present time this year. The Law Company have their new offices, sales and stock rooms all fitted out in convenient and attractive shape, occupying all the large second floor

of 85 John street, with their offices in front, giving good light and ventilation.

W.H. Gordon & Co., 115 Broadway, have prepared a new and handsome catalogue, which is now ready for distribution. The various electric light and power specialties and devices handled by them are fully described and well illustrated. Copies will be mailed upon application. This catalogue should do much to popularize this young and enterprising house among the light and power companies. Mr. Gordon reports an exceedingly brisk demand for the new fuse wire, which has rapidly found favor, and he is also well pleased with the rapid sale of the Ellis oil filters, whose use has already in many stations resulted in remarkable economy.

The Edison Electric Illuminating Company's Wiring Department, 432 Fifth avenue, under the management and superintendence of Mr. W. H. Cothren, is meeting with excellent success. My attention was attracted while passing there the past week to the new Hall electric pump operated by current from one of the Edison uptown stations, and exhibited in the front show window. Being a double piston pump, 16 c. p. lamps were placed on top of the two connecting rods over the oil cups, and were thus kept bobbing up and down alternately, and were lighted, causing quite a sensation. There were also exhibited two Kinsman arc lamps made by the Electric Construction and Supply Company, of New York, in full operation, in series. Mr. Cothren is running twelve of these lamps in front of Simpson, Crawford & Simpson's big dry goods house on Sixth avenue. He has also installed a number of isolated plants. Four 750-light Edison dynamos were put in the big Plaza Hotel, lately wired by the Tucker Electric Construction Company. This is said to be the finest piece of wiring in the city. Two 900-light Edison dynamos were put in the Methodist Book Concern and two 750-light dynamos in Ehret's Brewery. At the White Star pier are 300 lights, and it is said to be a pretty piece of lighting; at the Merchants' Bank are two 400-light dynamos. A large number of Hall pumps have been put in for pumping water, running elevators, etc. Since March last he has installed over 130 h. p. in motors of the C. & C. type, taking current from the Twenty-sixth and Thirty-ninth street stations. W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 5, Cook Building, cor. Franklin and Congress Sts.
Boston, Nov. 23, 1889.

Frank Ridlon & Co.—Mr. Frank Ridlon has leased part of the basement of the Hathaway Building, which he will use in future as a store for all kinds of second-hand machinery and a general repair shop.

Electricity and the Paper Trade.—At the first regular social and business meeting (followed by a banquet) of the Boston Paper Trade Association, the topic of "Electricity as a Motive Power" was discussed. Addresses were made by President Rogers and Mr. H. C. Spaulding, general manager of the Thomson-Houston Motor Department, and others.

The Wright Electrical Engineering Company have secured contracts for the installation of complete central stations, arc and incandescent, for the Randolph & Holbrook plant, and for Norwich. They have also a contract to wire the Grove Hall stables of the West End Street Railway Company, Boston, and are doing considerable construction work on the demonstrative section of the Portelectric Company at Dorchester.

Electric Piano Concerts.—Two concerts were given this week in Chickering Hall, which had the decidedly novel feature of the pianos being operated electrically. The concerts were arranged under the management of the Electric Piano Company and were pronounced a great success. The pianos are now on exhibition at 180 Tremont Street, where Mr. Bailey will be glad to explain their working to all interested.

Evans Friction Cone Company have just installed for the Attleboro Electric Light Company five sets of their special system of friction driving gear, two of which will be used for 50 h. p. generators, and three for 48-light dynamos. Other five sets will be supplied later. The Evans friction-gearing supplied to the Jamestown Electric Light Company, Jamestown, N. Y., is giving great satisfaction. This system is meeting with deserved favor, its extreme simplicity and great saving in floor space recommending it to all engineers.

West End Road, Boston.—The annual meeting of this road was held last week, when the adoption of electricity was referred to. The directors believed that electric cars solved the problem of street transportation. The construction charges for the new electric roads for the year were $562,674. After paying the charges and preferred stock dividend, the property earned a surplus of $227,000, equal to ten per cent. on the common stock, and the net monthly earnings are rapidly increasing. The introduction of the electric cars has given a great impetus to general travel in and around the city.

Wakefield, Mass.—Three companies are desirous of getting a franchise for the electric lighting of this city, namely, the Citizens' Gas Light Company, the Wakefield Electric Light Company, and the Wakefield & Stoneham Electric Light Company. A hearing was granted before the board of gas commissioners this week, but decision has been reserved. The Woburn Electric Light Company oppose the petition, or that part which referred to Stoneham, as they claim that their charter fully covers that town. The hearing has been adjourned until Monday, Dec. 2, at the office of the gas commission in Boston.

The Massachusetts Electrical Engineering Company, of 4 Post Office Square, this city, is a new organization which has a number of leading Boston engineers on its consulting list, and refers for indorsement to such men as Gen. F. A. Walker, Prof. C. R. Cross and others. The company will undertake whole charge throughout the range of electrical engineering, and will advise also on new plans, patents, machinery, etc. It will suffice to show that the company is well equipped if I mention that Dr. W. W. Jacques, Prof. S. W. Holman, Edward Sawyer, C. E., G. W. Blodgett and A. L. Plimpton are among its consulting engineers.

Mr. C. B. Fish.—Through some inadvertence, I unfortunately stated in my notes two weeks ago that Mr. Fish had been appointed general manager of the electric light company at Woonsocket. What I should have said was that Mr. Fish had been appointed general manager of the Woburn, Mass., Electric Light Company, in place of Mr Buck, who has retired. This company is now extending its lines to Stoneham and Lexington, and is wiring the town hall in Winchester for incandescent lights. Great improvements are also being made in the station, under the guidance of Mr. Fish, and, when completed, this will be one of the largest electric light stations in New England outside of Boston. At present they have five 50-light Thomson-Houston arc dynamos, one 35-light Brush, two 400-light Edison and one 500-light Thomson-Houston alternating dynamos.

Mr. W. J. Denver.—At a recent regular meeting of the Boston Electric Club, Mr. W. J. Denver, president of the club, was requested to accept a very excellent likeness of himself, in crayon, which is life size and mounted in an elegant frame. The picture was presented by a large number of his friends, members of the club, through their spokesman, Mr H. B. Cram, and now adorns the walls of the meeting room. As a sequel to this pleasant meeting, a complimentary dinner was tendered to Mr. Denver at Young's Hotel, on Tuesday evening, Nov. 19. Among those present were the following gentlemen: Messrs. George W. Adams, F. J. Boynton, John C. Wilson, Otis K. Stewart, J. R. Lovejoy, H. B. Cram, C. W. Holtzer, Frank Ridlon, F. W. Harrington, C. M. Ransom, A. B. Griggs, F. E. Pettingell, H. H. Eustis, Frank Fuller, William Brophy, J. R. Magee, E. H. Hewins, E. L. Caldwell, S. C. Peck, L. S. Dumoulin, A. L. Rohrer, George Manson, George B. Neal, H. D. Stanley, T. B. Doolittle and H. M. Daggett. Treasurer F. J. Boynton acted as chairman of the evening, and proposed the toast to the guest of the evening, which was drunk standing. Mr. Denver responded in his usual modest manner, after which a number of the gentlemen present testified to his worth and popularity in well-chosen and eloquent terms. Among the speakers were Mr. Ridlon, the first president of the club; Mr. Ransom, chairman of the board of directors; Mr. Lovejoy, Captain Brophy and Mr. Neal. A most enjoyable time was spent, and everything passed off with the greatest success. Many telegrams of congratulation were read from various points.

A. C. S.

WESTERN NOTES.

Branch Office of The Electrical World,
39 Mallers Building, Chicago, Nov. 23, 1889.

Mr. C. N. Fay has resigned as President of the Chicago Gas Trust, and G. K. C. Billings elected in his place.

The Knapp Electrical Works, Chicago, makes a specialty of furnishing crowfoot zinc for battery use in any quantity.

The City Electric Railway Company has been formed at Ottawa, Ill., to construct and operate an electric railway; capital stock, $125,000; incorporators, L. B. Merrifield, L. E. Enyart, W. N. Stend.

The Rock Falls Electric Company, at Rock Falls, Ill., is duly incorporated for lighting, power and heating, capital stock, $25,000; incorporators, A. C. Stanley, J. M. Bickford and B. F. Kadel.

The Electrical Supply Company, Chicago, state that the demand for their book of tables, No. 560, is beyond all belief, some of the requests coming from Australia and from different parts of Europe.

The Electric Light Company, of Raton, New Mexico, has been duly incorporated, with a capital stock of $10,000, divided among Russell Marcy, Harry Wigham, Geo. W. Cook, and M. A. McMartin.

Mr. Charles H. Cone, of the Knapp Electrical Works, Chicago, has returned from a trip through the Northwest, where he secured some handsome orders for Knapp annunciators and for Grimshaw wire.

The Superior (Wis.) Light and Power Company held their first annual meeting two weeks ago for permanent organization, and to take possession of the gas, electric light and water works plants which they have recently acquired.

The Central Electric Company has been strengthened by the admission of Mr. F. W. Cushing, who becomes the secretary of the company. Mr. Cushing left for Minneapolis a few days ago to superintend the drawing in of the Okonite cables into the subways.

Shay, Stevens & Co., Chicago, find their No. 12 porcelain insulator with wide base meets with the approval of electrical engineers everywhere, and their double-petticoated glass insulators are largely in demand on account of the deep, low-set groove which enables the lineman to secure a perfect tie.

Mr. W. M. Sheldon, of the Schuyler Electric Company, of Middletown, Conn., has been visiting old friends, and making many new ones in Chicago, while looking about for a suitable location for a set of offices. That Mr. Sheldon is a good judge of what an electric club ought to be is amply shown by his application for membership after a single visit to the rooms.

A Welcome Visitor.—The genial smile of General Manager P. H. Alexander, of the Sawyer-Man Electric Company, of New York, met the glance of his many friends in Chicago on Thursday last week when he came in on the morning train and left in the evening. As an admirer of Chicago weather, Mr. Alexander is not a success, and he could not help referring to our balmy Italian climate, etc., in a somewhat sarcastic manner,

Mr. G. Pfannkuche, of the Brush Electric Company, Cleveland, was entertained at the club rooms by Mr. Alexander Kempt, while stopping over in Chicago en route to St. Paul. Mr. Pfannkuche mentioned the fact that the demand for the new Brush alternating machine has so crowded the factory that an immediate increase in buildings is an imperative necessity, as they are now giving employment to all the workmen that can be economically handled in their extensive shops.

Telephone Quotations.—Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$305@$310	Cumberland	$ 60@ 70
Central Union	58@ 59	Wisconsin	114@ 115
Michigan	87@ 88	Bell of Missouri	150@ 151
Great Southern	32@ 33	Iowa Union	23@ 25
Colorado	36@ 38	Missouri and Kansas	57@ 58
Rocky Mountain Bell	40@ 41		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$ 80@$ 84	Chicago Edison Co	$100@$101

Electric Club Notes.—Among the visitors at the club rooms during the past week or two were the Hon. Benton J. Hall, of Burlington, Iowa; Saitaro Oi, a prominent Japanese gentleman from Tokio, Japan, who, with Notriet T. Lozier, of Chicago, dined at the club on Saturday last. The continued and growing popularity of the new club rooms is shown both in the numerous applications for membership and in the large number that daily gather in the rooms between the hours of 12 M. and 2 P. M., as many as thirty or more members dropping in at noon time to lunch, have a game of billiards or meet a friend. In this connection too much credit cannot be given to certain members who make it a point to spend as much time at the club as can be spared from their duties. Vice-President Alex. Kempt never lets a day pass without visiting the club rooms, unless absent from the city, and his endeavors to make the club a popular resort, both for social amusement and for practical information and study, especially for the junior and salaried members who cannot fly very high at present, is meeting with hearty encouragement. In addition to securing all the leading current literature, for which a sum of $50 has been appropriated, Mr. Kempt expects that the club will shortly have an extensive library containing all the late works on electricity, thus affording to the younger members a much-desired opportunity for securing the opinions of late authorities on electrical subjects. F. De L.

BUSINESS NOTICES.

Battery Cut-Out.—Attention is called to a simple device for disconnecting gas-lighting batteries if accidentally grounded. It is cheap, sensitive, never needs watching, and has no clockwork to be kept wound. Terms furnished by the Electric Supply Company, of Syracuse, N. Y.. No. 105 South Warren street.

A New Through Line to Denver and Cheyenne.—A new through car route has been established, via the Chicago & Alton and Union Pacific Railways, between Chicago and Cheyenne, via Kansas City and Denver. This through car will leave Chicago, on the Chicago & Alton "Kansas City Limited" train, at 6:00 p. m. daily, arriving at Kansas City the following morning, Denver the second morning, connecting at Cheyenne with the "overland flyer" for Ogden, Salt Lake City and all Pacific coast points. For all further information, tickets and reservation of berths in sleeping cars, apply to the city ticket office of Chicago & Alton Railroad, 195 South Clark street.

The Edison Electric Illuminating Company of New York, General Office, 432 Fifth Avenue,
New York, Nov. 7, 1889.

Mr. G. W. Gallaway, The Waste Oil Filter Co., 322 Pearl street, New York:

Dear Sir: I think if you call at the Berkeley Hotel you can sell a filter. I had the manager here to-day, and he thought it a great saving. I told him what I had done with it. It ran last month 1,048 hours, and used 64 gallons of oil; how does that favor the filter? I should be pleased to recommend it anywhere.

Yours respectfully,
A. S. Roseberry, Chief Engineer,
47 West 26th street, Edison Elec. Ill. Co.

Houston's Electrical Dictionary.—To the many favorable criticisms on Houston's Dictionary may be added the following: *Public Opinion:* "The work is a criterion of the wonderful progress of electricity in the arts and science. Electricity has advanced so rapidly that milestones have heretofore been neglected, and this is the first real landmark recording its inconceivable rapidity. Professor Houston's work fills a great and important need, and he has shown himself to be a conscientious as well as an able author. Considering the fact that no extensive work of the kind was already in existence, it is surprising to find the present one so completely comprehended and thoroughly done." *Buffalo Courier:* "What possibilities of adding to one's vocabulary are afforded by 600 pages of electrical terminology! Much of the work is illustrated, which fact, together with clear definitions, ought to do much to clear the way for the unscientific readers of electric literature."

Magnolia Anti-Friction Metal Co.—A recent friction test of Magnolia Anti-Friction Metal was made by Mr. H. G. Torrey, United States Assayer New York Mint, with the following results—time of test one hour:

	Time in minutes.	Magnolia anti-friction metal.*	Hoyt's genuine Babbitt.†	Deoxidized genuine Babbitt.‡	Pounds pressure per square inch.	Revolutions of shaft per minute.	Speed of rubbing surface per minute.
		Degrees F.	Degrees F.	Degrees F.	2 genuine Babbitts. Magnolia		Ft.
Temperature.	0	65	90	90	200 Lbs. 300	1,600	2,095
	10	115	156	140	300	1,550	2,030
	20	150	180	170	500	1,550	2,030
	30	160	230	230	800	1,500	1,965
	40	180	345	320	1,000	1,500	1,965
	45	...	397	...	1,000	1,500	1,965
	50	270	..	360	1,000	1,500	1,965
	55	...	..	375	1,000	1,500	1,965
	60	460	...	...	1,000	1,500	1,965

* Magnolia ran full time free without melting out or stopping machinery.
† Hoyt's melted and stuck to shaft at end of 45 minutes.
‡ Deoxidized genuine Babbitt melted and stuck to shaft at end of 55 minutes.

Respectfully, H. G. Torrey.
Charles Taylor, Assistant.

Storage Batteries:

New York, Oct. 30, 1889.

To the Anglo-American Electric Light Manufacturing Company:

Gentlemen: We have carefully considered the opinion of Judge Lacombe, recently delivered in an interlocutory proceeding in the case of the Electric Accumulator Company against the New York & Harlem Railroad Company and others, with reference to its effect upon the operations of your company. We find that the Court sustains the Faure patent, now owned by the Accumulator Company, as covering the application of the active material to the electrodes of a secondary battery in the form of a paint, paste or cement, prior to the immersion of said electrodes in the battery fluid. And we also find that the Court expressly says that the said Faure patent does not cover the application of the active material in a perfectly dry powder packed into the electrode, which electrode is not immersed in the fluid until it is placed in the fluid of the battery. We have carefully considered the process devised by Mr. Charles Sorley, in operation in your factory for the manufacture of plates, to the exclusion of all other processes. And we find that by means of said process the active material is not applied to your plates in the form of a paint, paste, or cement, nor are said plates immersed in any fluid prior to their insertion in the battery. Clearly, then, neither your plates nor your method of manufacture are covered by the claim of the Faure patent as the Court have now defined it. But further than this, we find that you prepare your active material in the form of a dry powder and pack it into plates, and then immerse said plates in the battery fluid without prior moistening or immersion in any other fluid. Therefore your method of manufacture is that expressly excepted from the claims of the Faure patent by the Court.

We regard Judge Lacombe's opinion as eminently favorable to your interests, for the reason that it expressly defines a mode of manufacture which can be carried on without infringement of the Faure patent. And as this mode of manufacture is followed by you, it necessarily results that you have the opinion of the Court rendered, as we happen to know, after a most elaborate presentation and argument of the case, squarely in your support. It therefore obviously follows that any assertions on the part of the Accumulator Company that you now infringe its patent are not founded on fact. Very truly yours, Ewing & Southard,
Park Benjamin, of Counsel.

Owing to the pressure on our columns, the Patent Record has been omitted this week.